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Contents for July, 1930

BUBBLE TOWER . . . . . FRONTISPIECE 426
Steel Tracery at an Oil Refinery

TIME . . . . . *By* L. MAGRUDER PASSANO 427
What Is It? — The Problem of All Times

PRINTS — THEIR USES AND ABUSES . . . . *By* CHARLES D. CHILDS 430
The Object of Collecting Should Be the Cultivation of Understanding

DYNAMIC LOADS . . . . . *By* EARLE BUCKINGHAM 434
Recent Experiments Suggest a New Factor in the Design of Gears and Other Moving Mechanical Parts

INAUGURATION OF DR. COMPTON 436
Induction of the Institute's New President on June 6 — The Inaugural Address

THE TECHNOLOGY LOAN FUND 439
Official Announcement of the Methods and Policies to Be Followed in the Administration of the New $4,200,000 Fund

THE REUNION IN JUNE . . . . . *By* ROBERT E. ROGERS 441
3000 Registered, Including 1300 Guests and 1700 Alumni; Only 2600 Registered in 1925

THE TABULAR VIEW 418
Notes on Contributors and Contributions

BOOKS 444
Review and Comment

THE TREND OF AFFAIRS 445
The Past Month in Science and Engineering

THE INSTITUTE GAZETTE 451
Relating to the Massachusetts Institute of Technology

THE COVER . . . . . *From a Water Color by* EDGAR I. WILLIAMS
"A Roman Doorway"

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Davis

BUBBLE TOWERS

STEEL TRACERY AT AN OIL REFINERY

The TECHNOLOGY
REVIEW

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TIME

What Is It?—The Problem of All Times

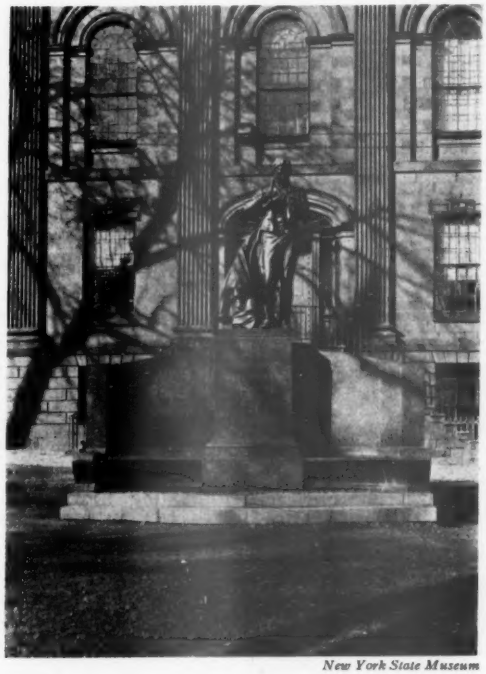
BY L. MAGRUDER PASSANO

IT MAY seem presumptuous in one who can call himself at most an amateur philosopher, or a dilettante, to attempt any expression of opinion on what has been called "the hardest problem in metaphysics" (Inge). But association with some philosophers and many scientists may serve as an excuse, since "evil communications corrupt good manners"; while a deep and sincere interest in the problem may be offered as a reason for the attempt.

To the majority, perhaps, of modern mathematicians and physicists time is — as are all other things — something to be measured. Taught by the various problems he attempts to solve the importance of exact and more exact measurement, the scientist has come to look upon the measurement of a thing as the thing itself. As if the length, breadth, and thickness of an object being accurately measured, the object itself would be completely known, so that it would be immaterial if the object were a lump of sugar or a lump of arsenic. Subjectively, if the scientist will admit such a term, the latter consideration would seem to be one of much importance. Time is more than its measurement. It, or he, can be, and is, murdered, as the Mad Hatter learned to his cost. If treated kindly it, or he, is complacent and gentle, exchanging the tedium of minutes and hours for a peaceful flow of days. After all does it matter much, *relatively*, whether time tells us the hour of the day, the day of the month, or even the year which "stays the same . . . for such a long time together"?

The subject of Time, however, is not one to be treated frivolously. The accurate measurement of time is a problem of the greatest importance; of no less importance is the accurate definition of time apart from its measurement. Philosophers have always recognized this, and today the scientist is coming to take greater cognizance of the philosophical aspects of his problems. A serious attempt to define time in such a manner as will satisfy both the mathematician, or physicist, and the philosopher, would seem to be a thing to be desired, since a definition that would satisfy the one but not the other would be incomplete, and as a consequence imperfect and false.

The accurate measurement of Time has held the attention of man from very early times, as is shown in the elaborate calendar systems of Mesopotamia, Egypt, and the Maya civilization of America, while the study of the nature and meaning of Time has occupied the attention of almost every one of the long line of philosophers from the ancient Greeks to the present day. A most recent attempt to treat the subject as a whole, with a knowledge of previous attempts made by both scientists and philosophers, as well as a knowledge of the most recent developments in mathematical, physical, and philosophical theory, is so important, so well and so interestingly done,



New York State Museum

STATUE, RECENTLY UNVEILED IN ACADEMY PARK, ALBANY, N. Y., OF JOSEPH HENRY (1797–1878), AMERICAN PHYSICIST AND GREAT SECRETARY OF SMITHSONIAN INSTITUTION. THE UNIT OF INDUCTANCE, IT WILL BE RECALLED, BEARS HIS NAME

M. I. T. Photo

LEFT PANEL OF NEW MURAL DECORATIONS PAINTED FOR THE INSTITUTE'S WALKER MEMORIAL BY EDWIN H. BLASHFIELD, '69, SUPPLEMENTING HIS DECORATION OF THE SOUTH END OF THE HALL

that it seems worth while to present a *critique* of the work. Perhaps by so doing, readers may be induced to turn to the work itself.*

A survey of the notion of time in ancient, particularly Greek, philosophy, which reveals again the dependence of us moderns upon Greek thought, is followed in Professor Gunn's work by an account of the mediæval conceptions of time, of which that of Augustine is honest if not very enlightening: "What, then," he asks, "is Time? If no one asks me I know; if I wish to explain it to one that asketh, I know not." Of one thing, however, he was sure: that time, whatever it may be, was "created by God at the creation of the world;" a belief comforting, doubtless, to the thinking fundamentalist — if fundamentalists do think. How this conception can be reconciled with the other, equally valid, doubtless, that "In the beginning was the word," must be left to the theologians or to the scientific reconcilors of science and religion. "In the beginning" implies time (There stands Religion); but when the world (and motion), were created time also was created and measured. (There stands Science.) The reconciliation follows obviously.

Augustine distinguished between psychological and objective time. He perceived that time is "a certain extension." He perceived, following Plotinus and preceding Poincaré, that as "we use time to measure motion, . . . so we cannot well use motion to measure time." But in spite of many foreshadowings of modern ideas, "For the scholastic mind," says the author, "time, like space was unimportant." Perhaps, however, it was not so much that Time and Space were unimportant as that they were overshadowed by the far greater importance to the scholastic mind of God, the creator of Time as of all other things. It was "the new science that was rising under the impetus of thinkers such as Galileo, Newton, and Leibnitz, that was to "raise both space and time . . . to the rank of supreme or fundamental realities of the physical world."

TRACING progress through what he calls the "early moderns" the author points out that anticipations of Relativity contained in the philosophy of Descartes were sacrificed by science to "the more immediately useful" hypotheses of Newton; and, as the creator of time, God himself was, not sacrificed precisely, but relegated to the background of the picture, the foreground being filled by the bodies of the cosmos moving mechanically and objectively, in space and time. Time had become "an objective reality independent of our perception of it," and, moreover, of interest only as measurable. Newton, indeed in his Absolute Time, or "duration" assumed a something, flowing uniformly, the measurement of portions of which gives us relative or common time. But, "Newton's Absolute Time, like that of the Relativists, was based, not on a specific inquiry into the nature of Time as such, but upon physical and mathematical requirements, dictated by the science of the day." Newton to justify his Absolute Time, postulated also Absolute Motion, which, he says, we know, and Absolute Space;

*THE PROBLEM OF TIME: AN HISTORICAL AND CRITICAL STUDY. By J. Alexander Gunn, M.A., B.Sc., Ph.D., Professor in the University of Melbourne. Sometime Fellow of the University of Liverpool. New York: *Richard R. Smith, Inc.*

and out of this Corot-like landscape God advances again to the foreground, so that, as the author remarks, "if the baffled physicist . . . cannot tell whether a given motion is relative or absolute, he can at least reply 'God knows.'" What the contemporary physicist would reply in such a dilemma can only be conjectured.

Through what the contemporary scientific and pseudo-scientific age would doubtless call the "arid wastes of philosophy and metaphysics;" past the overthrown, buried, or partly buried collossi, sphinxes, statues, and temples of old discarded gods; the Lockes, Berkeleys, Leibnitzes, Kants, Hegels, and their schools, the reader seeking knowledge is led past such figures as Michelson and Morley, Lorenz, Fitzgerald, Minkowski, already weather worn, past other figures still standing erect, on to the oases where dwell the living: Eddington, Whitehead, Einstein. But even this passage of the desert is made interesting by lucid and informed résumés, expositions, and criticisms of the various philosophers and schools in their relation to the subject of Time. Moreover, the author's literary style is unusually entertaining and unusually clear, so that the reader has a sense of understanding not often felt by the layman.

TO LOCKE belongs the honor of clearly distinguishing between time as a percept and time as a concept and to him also, perhaps more than to any other, the honor of a clear distinction between subjective time and objective time, the former arising from our sense of "succession in duration" as contrasted with the idea of our "enduring awareness of the (permanent) self"; the latter arising from "the movements of the heavenly bodies which offer us an . . . objective system of reference and *appear* to give us units of duration which are *approximately* uniform." He did not, however, attempt to reconcile these two ideas, so that even today (or yesterday) each of the two has its champion; the one in Bergson, the other in Einstein.

The problems still remained unsolved, though restated, by Kant and his successors, and even today are matters of controversy. They were not caused by Relativity, which as a purely mathematico-physical theory is concerned only with the objective aspect of time; they are problems of metaphysics and as such may be insoluble. None the less are they important and their discussion of transcendent interest to one, scientist or not, whose horizon is not limited by his own myopia. In two chapters on "The Physicists and the Problems of Time-Measurement," and "Time in Contemporary Metaphysics," the author discusses fully the treatment of the problem in contemporary thought, and the efforts at reconciliation or coalescence being made by both physicists and metaphysicians. Unlike Galileo, the present day physicist admits the existence of other than his measurable time, while the philosopher accepts, with cheerful faith, if not with complete understanding, the theories of Relativistic measurement. Together they direct their efforts to the formulation of a metaphysical theory that will satisfy both.

IT CANNOT be too strongly urged that *measurement* cannot determine the *nature* of time; nor does calling time a "fourth dimension" determine (*Continued on page 456*)

M. I. T. Photo

RIGHT PANEL OF BLASHFIELD MURALS WHICH PRESENT ALLEGORICALLY THE USE AND ABUSES OF SCIENCE (OPPOSITE PAGE) AND THE PROGRESS OF HUMANITY LED BY EDUCATION (ABOVE)

PRINTS—THEIR USES AND ABUSES

The Object of Collecting Should Be the Cultivation of Understanding

By Charles D. Childs

Accompanying Print Reproductions by Courtesy of Goodspeed's Book Shop

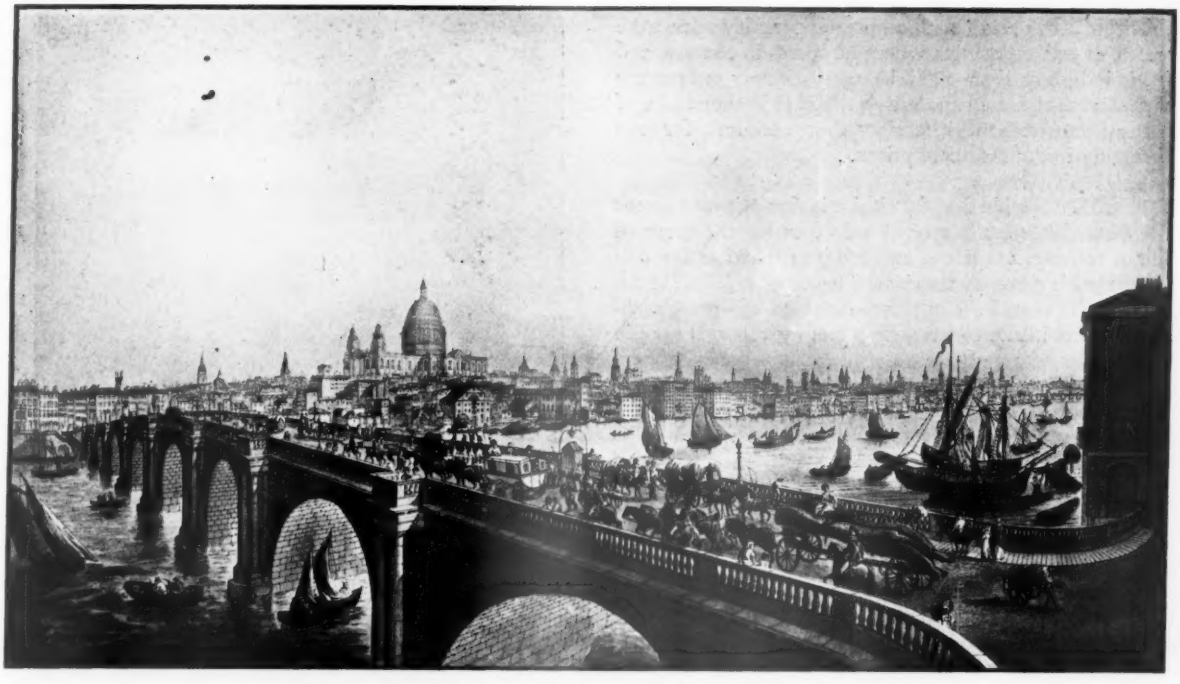
"PRINT" as a term has lost some of its original meaning by the freedom of its application but actually it is an impression from a block, stone, or plate, created by contact with an inked surface upon which a design has been prepared. Fine prints are made by the same methods as all others except that all images done on plates, blocks, or stones must have been actually drawn there by hand, not by mechanical means. The mediums by which such prints are made are etching, engraving, mezzotint, aquatint, and lithography. No reproductive processes enter this field. A photograph, for instance, is not a print as it is manufactured by chemical reaction of light against a sensitive film.

Printed pictures in the western world originated in the Fifteenth Century. Throughout four centuries, they have been of incalculable assistance to the progress of culture and the free transmission of thought from one people to another. With such a background there is an irresistible inducement to acquire and study the records of particular times and phases of this great historical pageant. One commendable desire to collect is that of the student, whose endeavor is directed toward the broadening of his knowledge. But to the layman, the act of searching out and acquiring fine things, whatever they may be, is always made enticing by the knowledge that others are quite as eager and as quick to get wind of a find. Collecting as a game has some of the flavor of hide-and-seek. Certainly diligent search is well rewarded and many hidden things have been brought to light by the persistence of the players.

LINE ENGRAVING — "LITTLE HORSE" BY DÜRER, 1505

EARLY NINETEENTH CENTURY AQUATINT — ENGLISH ANGLING SCENE

Few of us are immune to the pleasures that lie in owning something desired by others. As children our acquisitiveness centered upon things of immediate interest, marbles, tops, and those possessions which were considered by general agreement to be of paramount importance. The adult mind is sometimes loathe to surrender all remembrance of its youthful indulgences and retention of early interests is no doubt responsible for many mature excursions into the realms of pirates, Indians, cowboys, aviators, and mariners. Many of us, indeed, find our zest in



NINETEENTH CENTURY AQUATINT — "A VIEW OF LONDON" BY SCHUTZ

these and kindred subjects enhanced with the years, and who can say that adventurous souls will ever call them dull?

IN COLLECTING prints there is almost no limit to the variety of subject and size available to those who are inclined to delve. According to his taste the enthusiast may house his possessions in a match box, or he may find it necessary to occupy the larger part of his garage and attic. The extremes in size may be found, for example, in the beautifully executed miniature prints of George Baxter and the ultimate in huge color plate accomplishment represented by the portraits of American birds by Audubon.

Fine prints are the acknowledged aristocrats of the collector's flock. Their value is twofold. They represent one of the highest types of creative ability and as such have an honored place in our standard of aesthetics and they are no less important as articles of merchandise. The monetary value of prints is determined by the same law that governs trade the world over — the law of supply and demand. When the worth of objects of art is dispassionately considered over a period of centuries rather than years, only the best endure, and of these there are only too few. Rembrandt, Dürer, Schongauer, the Primitives in Italy and Germany, to mention only a few, have had the homage of collectors for hundreds of years. They are our tradition, and tradition is no empty word when it is intended as a measure of achievement proved by time. Today many critics hold it up to the ridicule of an unthinking public. In their haste to be modern they are often unjust to much that is fine in the past. The purpose of the critic should be to stimulate rational thought, not to beat it down with a barrage of individual opinion.

ETCHING — "CLEMENT DE JONGHE" BY REMBRANDT

Personalities, fads and mannerisms have always engaged the attention of a public which is easily swayed by advertising and publicity. Today, more than ever before, these influences are apparent. The object of collecting fine prints should be to cultivate understanding and appreciation of the work of those who have helped to build the structure of our artistic inheritance. It is a temptation to say that collectors need to think more about the motives which actuate their collecting.

In our modern life it has become difficult to maintain a personal standard of thought. We prefer to have our decisions made for us. The alertness of our separate minds has been dulled by the atrophy of that keenness of perception developed only through independent reasoning. We are susceptible to styles in prints as in all else. This mode is offered to us and we accept it until the advent of the next, which is hailed quite as eagerly as its predecessor.

The dealer in prints finds ample opportunity to test the mettle of collectors with whom he comes in contact, and if his judgment is sane and balanced he may temper the enthusiasm of his clients wisely. It is this abundance of enthusiasm without direction that accounts for the accumulation of mediocre prints.

THERE is a wide field for choice in fine prints of recent years. Whistler, responsible in part for the renewed life of etching, has left as an heritage for artists and collectors such gems as those which compose The French Set, The Thames Set and the two groups of Venice etchings. The influence of his style is readily apparent even in the manner of our greatest living etchers. James McBey, one of three leading English etchers, quite frankly acknowledges in his prints his debt to Whistler. In D. Y. Cameron some adherence to Whistlerian principles is noticeable but even more evidence witnesses his bond with Meryon, the great Frenchman. Contemporary art has, in Muirhead Bone, the greatest exponent of drypoint within the history of etching. He will be ranked with the masters.

The outlook for art in America has never been so bright as it is today. Of international reputation are, with others, Bellows, Davies, Benson, Pennell, Heintzelman, and Arms [John T.], and there is no end of talent among the younger men.

The appeal of architecture has been very strong to many of our most able contemporaries. Samuel Chamberlain, '18, Martin Lewis, and Louis C. Rosenberg, '13, to mention only three, are making a splendid contribution to the cause of modern etching. George C. Wales, '89, has done much to preserve in prints the prestige which American clipper ships gained through their speed and grace of design.

Chamberlain and Rosenberg keep alive the beauty of the Gothic. Their sketches in France, Spain, and Italy are now in much favor with American collectors. Martin Lewis has caught the true spirit of ever-changing New York in his several fine views of that city. A keenly observant artist and a humorist of parts, Lewis has given the "Sidewalks of New York" a permanent place in the portfolios of the connoisseur. His power to catch the spirit of the crowd is apparent in several plates so excellently descriptive that they might well be divided into groups representing the hours of the day. The early morning rush is pictured in "Quarter of Nine — Saturday's Children," a scene at the junction of Park Avenue and Thirty-fourth Street, and no finer effects of chiaroscuro than "Fifth Avenue, Night" and "The Great Shadow" can be found in contemporary etching, with the possible exception of Muirhead Bone's "Rainy Night, Rome," and "Spanish Good Friday, Ronda."

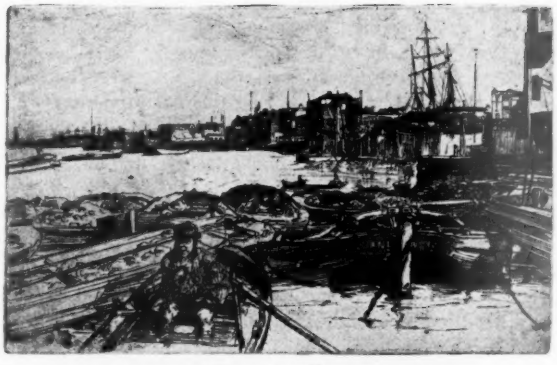
AMERICAN MEZZOTINT — "CAPTN. ISAAC HULL" BY D. GRAHAM

LITHOGRAPH — CARTOON OF LINCOLN PERIOD BY CURRIER AND IVES

Chamberlain has not only perpetuated the pictorial qualities of many famous and lesser known architectural masterpieces but he has written of them with a happy drollness that makes delightful reading. The best qualities of his work are apparent in such prints as "The Sunlit Tower, Colmar," "Verneuil," and the "Battered Boat, Villefranche."

Rosenberg has done many descriptive plates which have become favorites of collectors everywhere. The originality of his style and methods is unquestionable.

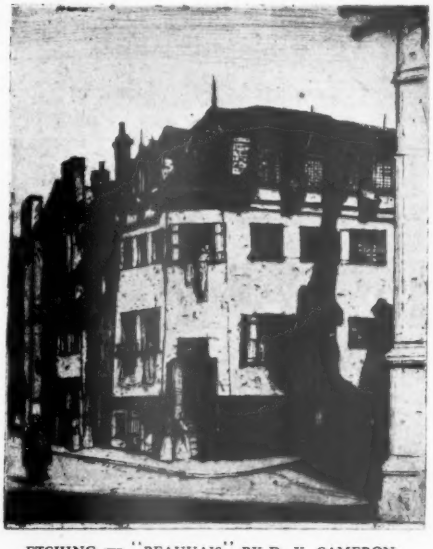
American etching societies and museums, aided by the growth of public interest, have encouraged an ambitious spirit among artists.



ETCHING — "THE POOL" BY WHISTLER

Many promising men may be pointed out in all sections of the country. It is not by intention that the names of these men are excluded here. The few who have been mentioned are merely typical of the larger body who form the backbone of our national art.

A great deal of progress has been made in other mediums than etching. Lithography and wood-engraving are challenging the long reign of the copper-plate, and in truth a period of original expression in all the graphic mediums seems to be well under way.



ETCHING — "BEAUVAIS" BY D. Y. CAMERON

FROM fine prints we turn to another class which is not necessarily inferior artistically, but in which the stronger appeal is made through its subject matter — historical or, as they are sometimes called, story telling prints. Historical prints are in reality records of people, places, and events that have been of sufficient importance to warrant a pictorial description. Their value in supplying material for research cannot be underestimated, and few written accounts tell so graphic a story as a well conceived picture which is truthful in the news it presents. The demand for prints of this qualification has always been insistent. Students and collectors in general have helped to preserve the all too meager supply.

Within only a few generations America has begun to realize that it has a tradition and to be proud of it. Today we are offered the spectacle of a people frantic in their desire to own some example of the arts and crafts of their forebears. Collectors of a few years ago who refused to be warned by a tendency of the masses to insert a finger rather gingerly into their pie, now find that the pastry has been almost completely consumed, and their wrath at the discovery is not diminished by the fact that the cost of their particular delicacy has advanced in proportion to its popularity.

A few years ago the names of Currier and Ives were known only to those who grew up in the "Mauve Decade" and to certain remarkable pioneers who seem always to anticipate the trend of public favor. Today, if these purveyors to the popular palate are unknown to a single inhabitant of the states he must be a modern Rip Van Winkle, completely isolated from the world. The artists employed by Mr. Currier and Mr. Ives may not always have been skillful but they were certainly industrious. A veritable flood of pictures was prepared for the delectation of a receptive populace whose response to this kindness kept the wheels of progress turning for some fifty years without a break.

It is only just to say that there *were* artists of real talent among those who drew for Currier and Ives and in the class of large folio prints such as the clipper ships, the western and railroading subjects, the rural, sporting and city views, there is evidence of able, even though unpolished, genius. On the other hand we cannot overlook such ludicrous flights of fancy as characterize a pair of prints which is before the writer at the moment. "The Fairies' Home," in which a group of gambolling sprites make merry within a wooded dell, under the light of a benignant and very yellow full moon, while the approach to their retreat is guarded by two mother-of-pearl and coral-colored sea monsters of impossible proportions, is ideally mated to its companion, "The Bower of Roses," which reveals the graces of a reclining and somnolent maiden to her palpitant gallant, a youth of raven locks, attired luxuriously in a scarlet and somewhat abbreviated ballet costume. His attitude of astonished admiration is heightened by a graceful fluttering of the right hand and a delicately poised position upon the ball of the foot, which we feel sure will not maintain his equilibrium indefinitely, and which we fondly hope will precipitate him into the swiftly flowing stream upon whose brink he rests. (*Continued on page 462*)

DRY POINT — "OXFORDSHIRE" BY MUIRHEAD BONE

DYNAMIC LOADS

Recent Experiments Suggest a New Factor in the Design of Gears and Other Moving Mechanical Parts

By Earle Buckingham

THE nature and extent of actual working or dynamic loads on supporting or driving elements of a mechanism have long been open questions. In the absence of any evidence to the contrary, these dynamic loads have generally been considered as directly proportional to the applied or transmitted load. Thus certain velocity factors have been established by running mechanical elements, such as ball bearings and gears, at various velocities and imposing a sufficient load to cause destruction. These applied loads are then divided by the static load which would cause failure, and the results have been used as velocity factors. Thus if a pair of gears running at a certain speed should fail under a transmitted tooth load of 1,000 pounds, and these same gears would fail under a static load of 3,000 pounds, the velocity factor would be one-third. It is then assumed that under these same velocity conditions, the dynamic load is three times the transmitted load, so that with a transmitted load of 250 pounds the dynamic load would be equal to 750 pounds.

In 1892, the late Wilfred Lewis, '75, presented a paper before the Engineers' Club of Philadelphia on the Strength of Gear Teeth in which he proposed the use of a formula for calculating the strength of gear teeth, which is now known as the Lewis formula, and is used by most designers. This formula is based on static stress conditions. He states in this paper: "What fiber stress is allowable under different circumstances and conditions can not be definitely settled at present, nor is it probable that any conclusions will be acceptable to engineers unless based upon carefully made experiments. Certain factors are given as applicable to certain speeds, and in the absence of any later or better light upon the subject, Table II has been constructed to embody in convenient form the values recommended. It can not be doubted that slow speeds admit of higher working stresses than high speeds, but it may be questioned whether teeth running at 100 feet a minute are twice as strong as at 600 feet a minute, or four times as strong as the same teeth at 1,800 feet a minute."

IT WAS not until about 1911 that any extensive and systematic tests were undertaken to obtain more reliable data on this subject, when Professor Guido H. Marx, at Stanford University, made an extensive series of tests by running cast iron gears to destruction. These tests were continued in 1915 with the assistance of Professor Lawrence E. Cutter, and included tests with the pitch line velocities running up to 2,000 feet a minute. Velocity factors were established in the conventional manner from the results of these tests. Ralph E. Flanders, in the discussion of their report, makes the following comments: "In regard to the dynamic qualities of the material, is it safe to use Table 6 for all materials? Does not the strength of a gear running at high speed depend more on the dynamic qualities of the metal than on the static strength? Would the coefficients of Table 6 derived from cast iron be correct when used for mild steel or when used for special heat treated alloy steels, such as used in automobile practice?"

"It is also important to know how much the accuracy of the cutting affects the strength of gears at high speed. The chances are that a high premium is put on accuracy from the standpoint of strength. If this is so, it should be definitely known, though it is not practicable to include this factor in a formula."

The validity of the use of a velocity factor has been questioned from time to time. It has been suggested that the actual dynamic load is the combination of two loads: first, the transmitted or useful load and second, an additional or increment load set up by inaccuracies, unbalance, fluctuating applications of load, and so on. In an article published in *Zeitschrift des Vereines deutscher Ingenieure* in 1899, Oscar Lasche discussed the probable effects of errors and masses and the large increment loads that might result from them at high speeds. In a paper read before the British Institute of Mechanical Engineers in May, 1916, Daniel Adamson discussed the probable value of the increment loads along similar lines to those followed by Lasche.

As a result of correspondence between Wilfred Lewis, Daniel Adamson and Charles H. Logue, Lewis proposed in a paper read before the American Society of Mechanical Engineers in December, 1923, the construction of a gear testing machine that would enable these increment loads to be measured. As the result, a special research committee was organized by the Society with Wilfred Lewis as its chairman. Arrangements were then made to build the testing machine and to have a series of tests conducted on it in the laboratories of the Department of Mechanical Engineering at Technology.

The first series of tests were started in 1925, and successive series have been continued up to the present time. These tests have been conducted by students, supervised by the writer. The analysis of the test results has proved to be a long but interesting task. Much of the success of this analysis is due to the assistance and suggestions of Carl G. Barth, a member of the research committee who has given freely of his time and efforts towards making the investigation a success. The last series of tests required to determine experimentally the influence of the several different factors involved was completed in February, 1930. Although these tests were confined to the study of dynamic loads on gear teeth, the results and their analysis throws considerable light on the nature of other types of dynamic loads.

THE critical load on any construction is always the most severe one or maximum load. This may be carried but momentarily, yet the structure must be strong enough to withstand it. These tests have indicated very clearly that the dynamic load is not directly proportional to the applied or transmitted load. The maximum load is an impact load, and its intensity is the sum of the transmitted load plus an additional or increment load whose intensity is dependent primarily upon the speed of operation, extent of the error in the shape of the contracting surfaces, masses of the moving bodies, and the elasticity of the contacting surfaces and connecting members of other moving masses. This additional or increment load is nearly independent of the transmitted load and is therefore practically a constant for any given speed on any given mechanism.

This impact load is the primary cause of wear on rubbing surfaces, causing high compressive stresses in the materials, which result in compressive fatigue of the materials. This compressive fatigue releases small particles of the material, their size and shape depending upon the structure of the material. These released particles may then cause abrasion of the rubbing surfaces until they have worked themselves clear of the rubbing surfaces.

TO RETURN to the subject of gears: errors on gear tooth profiles together with their deformation under load cause the masses on the driving and driven shafts to change their velocities slightly. The change in momentum thus introduced tends to cause the tooth surfaces to separate. This separation is resisted by the transmitted load. The amount of separation depends upon the extent of this change in momentum and the intensity of the transmitted load. For any given condition, the greater the transmitted load, the less this separation will be. After separation, the tooth surfaces come together again with an impact. The intensity of this impact depends upon the distance that the teeth have separated and the intensity of the transmitted load. But the amount of separation depends also upon the extent of the transmitted load. Thus the additional or increment load set up by this impact depends primarily upon the amount of change of momentum in the revolving masses caused by the errors in the tooth profiles. This, as may readily be seen, is practically a constant for any given construction at any given speed. The impact load is much more severe than the load which exists when the additional momentum is imparted to the masses because this separation effort continues for a relatively much greater length of time than does the impact.

The dynamic loads on other machine elements will be found to be very similar in many respects to those on gears. For example, consider a plain bearing. No mechanical part is ever perfect in form and size. Imperfections in the form of the shaft would tend to lift the masses mounted on it. Unbalance in the revolving parts will also set up other additional loads. Fluctuations in the transmitted load are always present, caused by gear tooth action or the stretch and creep of a belt on a pulley and by the changing load conditions on other connected parts. As a result, some vibration is always present in revolving parts, and the predominating period of vibration of a rotating shaft is the same as its period of rotation. This makes possible the successful use of vibration tachometers. The result of this vibration on the bearings is a series of impacts. The momentum to be absorbed by the bearings depends primarily upon the masses and the speed of the shaft and other permanent conditions of operation of the mechanism. Here again, the dynamic load will be the sum of the transmitted or applied load plus an increment load which will be practically a constant for any given speed condition on any given mechanism. When the period of vibration, or rotation of the shaft, is synchronous with the natural vibration period of the loaded shaft, we have what is known as a critical speed when the vibrations are more severe and the impact loads on the bearings are correspondingly increased.

AN ANALYSIS of the load conditions between any other types of moving surfaces of a mechanism will show that the maximum load is an impact load of similar characteristics to those discussed. Hence instead of using a velocity factor established from break-down tests, the test loads which cause failure should be subtracted from the static strength of the particular part under test, and this difference is the increment load which should be added to any applied or transmitted load to obtain the dynamic load for the specified speed condition. Thus if under certain speed conditions, failure takes place with a transmitted load of 1,000 lbs. on a machine element which fails at 3,000 lbs. under static conditions, the increment load here is equal to 2,000 lbs. If a load of 250 lbs. is transmitted at this same speed, the dynamic load will be about 2,250 lbs. instead of 750 lbs. which is the assumed condition when a velocity factor of one-third is used.

Again, if the foregoing test involved the use of mild steel, and we substitute an alloy steel whose physical properties are four times that of the test sample, its static strength would be equal to 12,000 lbs. If the use of a velocity factor were correct, this part should fail under a transmitted load of 4,000 lbs. at the same speed conditions. Instead of that, it would require a transmitted load of about 10,000 lbs. to cause failure. This example should give some idea of the advantages of the use of the stronger alloy steels in machine construction.

With the use of such increment load values, it is possible that a "margin of safety" should be substituted in place of a factor of safety. As has often been stated, a factor of safety is another name for a factor of ignorance. In the first example, with an increment load of 2,000 lbs. and a transmitted load of 250 lbs., we have a margin of safety of 750 lbs. The factor of safety in this case would be 1.33 which seems low according to our usual ideas. However, a margin of safety equal to three times the transmitted load should seem ample.

In the second example, if we use a margin of safety equal to three times the transmitted load, this applied load would be equal to 2,500 lbs., the increment load would be equal to 2,000 lbs., whence the dynamic load would be equal to 4,500 lbs. In this case, the factor of safety would be equal to 2.66.

IT SHOULD not be assumed from the foregoing that an increase in the physical strength of the material alone will always enable greatly increased loads to be carried. If all other factors remain unchanged, (*Continued on page 464*)

INAUGURATION OF DR. COMPTON

Induction of the Institute's New President on June 6—The Inaugural Address

IN a stately ceremony marked by the splendor of traditional academic pageantry, Dr. Karl Taylor Compton was inducted into the Presidency of the Institute on Friday, June 6. More than 4,000 guests witnessed the inauguration and of these at least 2,000 were Alumni attending the All-Technology Reunion.

Eastman Court, the great quadrangle formed by the three sides of the main group of Technology academic buildings was the majestic and massive setting for the ceremony. Pink and white rhododendrons in full blossom marked the borders of the broad lawn and presented a fitting repetition of the colorful hoods, the berets, the tam-o'-shanters, and robes worn by those in the procession. The classic colonnade surmounted by the Institute's great dome formed the background for the dais upon which the speakers and delegates were seated.

The academic procession headed by Alexander Macomber, '07, included representatives of the leading colleges of America and abroad as well as of learned professional societies, of the Army and the Navy, of the State and of the city governments of Boston and Cambridge. In addition to these delegates, the procession included members of the Institute's Corporation, former Presidents of the Alumni Association, and members of the Institute's Faculty.

At three o'clock the band swung into the stirring strains of Lachner's "March Celebre", and the Presidential and Academic Processions appeared from opposite sides of the Great Court, slowly marching forward to meet at the central aisle. Here Chief Marshal Macomber turned and led the procession northward toward the platform, and Drs. Stratton and Compton, with their escort of Seniors marching four abreast, followed. More than 700 were in the processional.

Marching directly behind the Chief Marshal and his two aids, Professors John H. Zimmerman, '23, and George E. Russell, '00, were President John Grier Hibben of Princeton, President A. Lawrence Lowell of Harvard, the Rev. Henry K. Sherrill, Bishop-Elect of Massachusetts, and Dr. Samuel C. Prescott, '94, Chairman of the Institute's Faculty. Admiral Philip Andrews, representing the United States Navy, and General Merriweather Walker, Commandant of the First Corps Area of the United States Army, marched together, their uniforms adding color to the procession. Dr. Payson Smith, Commissioner of Education, who represented Governor Allen, had as his escort Dean Harold E. Lobdell, '17. Mayor Richard M. Russell of Cambridge was escorted by

SPEAKERS' DAIS. DR. STRATTON IS DELIVERING HIS ADDRESS

Dr. James L. Tryon, and Mayor James M. Curley of Boston was escorted by Registrar James C. MacKinnon, '13. Professor Frederick W. Adams, '20, acted as marshal for the delegates, and Sir William Bragg, one of England's most distinguished scientists, speaker at Technology's commencement the following Tuesday, led the long line of representatives of educational institutions and learned societies. He represented the Royal Institution, and had as his escort Dr. Harry M. Goodwin, '90, Dean of Graduate Students. Following came the representatives of the colleges and universities, marching in the order of the founding of their institutions.

Chief Marshal Macomber opened the ceremony by introducing the Rev. Dr. Sherrill who made the invocation. His voice was carried clearly to all parts of the Great Court by a public address system arranged by members of the Department of Electrical Engineering. Dr. Stratton made the opening address paying tribute to Dr. Compton and welcoming him as the Institute's new President. He described the new administrative arrangement whereby Dr. Compton is to be President and whereby he, Dr. Stratton, is to be Chairman of the Institute's Corporation.

Dr. Compton then delivered his inaugural address presented below. President Hibben of Princeton, where Dr. Compton has been head of the Department of Physics,

next spoke. "It is a privilege," said he, "to express to the Massachusetts Institute of Technology and to President Compton for myself personally as well as officially for Princeton University, our very hearty felicitations upon this occasion. I find myself in two moods today, one a feeling of genuine rejoicing with you, the Corporation, Faculty, Students, and Alumni, that you have secured as your President a man of such notable attainment and of still richer promise. There is the mood, also, of poignant regret that Princeton must lose in order that you may gain." He continued with a review of Dr. Compton's career and paid him as well as his parents a great tribute. "My own personal wish and expectation for him," concluded Dr. Hibben, "I would put in the words addressed many years ago to another facing an adventurous and difficult task: 'He shall have so much courage that he shall never be weary and he shall think not on joy or sorrow that he hath had but only on the thing that lieth before him.'"

President Lowell of Harvard brought the greetings of that institution: "We have met to welcome you to the title and duties of President of the Massachusetts Institute of Technology. Much have we heard of, greatly do we esteem your contributions to physical science pure and applied; and now we look forward to your administration of a body founded for these aims. In your manifold labors you will be helped by the experience, the wisdom, and the vast knowledge of Dr. Stratton, to me a near neighbor and a cherished friend. . . .

"One who has seen a sapling grow to a mighty oak may almost doubt his recollections. For its fame and power, Technology is not old among institutions of higher learning and in its early years obstacles of no common menace barred its path . . . Did I compare it to an oak? Excuse the inappropriate simile, for a tree has a limit to its size. . . . What demands the public may hereafter make we do not know, but we are sure they will be great, and in meeting them may your administration be memorable."

Dr. Stratton next introduced Sir William Bragg who spoke extemporaneously and brought the felicitations of the Royal Institution of Great Britain. After he had concluded, Chief Marshal Macomber declared that Dr. Compton was inaugurated President and the recessional formed and marched southward down the center of the Great Court.

DR. COMPTON'S inaugural address follows: "Permit me to take this opportunity briefly to discuss certain features of the Massachusetts Institute of Technology which have induced me, with real enthusiasm, to cast my lot with you as a part of this new organization. I venture to hope that this is appropriate because the significance of these considerations is not primarily to me personally, but to every one who is interested in science, and in the

INAUGURATION CEREMONY AS IT APPEARED FROM ATOP BUILDING THREE

contributions which science has made and will in the future make to the happiness and welfare of mankind.

"The three most pertinent questions in evaluating any institution would seem to be, 'What is its purpose?', 'What is its accomplishment?', 'What is its future?' It is through its answers to these three questions that the Massachusetts Institute of Technology commands allegiance and support.

"I venture to formulate the purpose of the Institute as 'the development of science and its useful applications', and to describe the method of accomplishment of this purpose as being 'through continual study and research combined with the training of men'. This purpose is dictated by the opportunities found in modern science for contributing in such a fundamental way to the necessities of life that it is not surprising that the distinguished founder of this Institute, William Barton Rogers, expressed it and recommended the means to accomplish it in words which are every bit as significant today as they were when he wrote from Virginia in 1846 to his brother Henry in Boston, outlining his plan for an Institute of Technology. This was fifteen years before the Institute was incorporated and nineteen years before it was actually opened. He says:

"'The true and only practicable object of a polytechnic school is, as I conceive, the teaching, not of the minute details and manipulations of the arts, which can be done only in the workshop, but the inculcations of those scientific principles which form the basis and explanation of them; along with this a full and methodical review of all their leading processes and operations in connection with physical laws.'

"Dr. Rogers then goes on to outline an organization and a curriculum which are astonishingly like those of today, which have stood the test of time and experience. As an example of constructive imagination, good judgment and prophetic vision, I wonder whether there is an equal to this in educational literature!

"Turning now to the question, 'What has been the Institute's accomplishment?', I almost hesitate to attempt an answer, because its direct and indirect influence have been so enormous. As the first category of accomplishment I would mention its Alumni. They comprise builders of huge industries, organizers and executives of great companies, leaders in science, engineering and architecture, and a great host of men who are ably engaged in operating and developing the vast industrial system which is the distinguishing feature of our present civilization. And in educational work they have taken an equally prominent part. For example, I recently visited a great mid-western university in which I found that all four of the deans were Technology men. During the past few months, since I have become so particularly interested in the Institute, I have been continually amazed to discover how important a rôle its Alumni are playing in the life of the country. There can be no doubt regarding the value and vigor of an Institute which has trained such men.

"As the second category of accomplishment I would point to the other great technological and engineering schools now scattered all over this country, which are the direct offspring, so to speak, of the Massachusetts Institute of Technology and patterned after the original plan of President Rogers, each with an individuality born of local conditions or of desire particularly to emphasize one or another aspect of the general plan. In this providing a pattern and also to a very large extent the faculties for these newer technical schools, the Institute is in the position of the founder of a sturdy and illustrious family. And this is true not only in this country but also abroad. It is held, for example, that the tremendous technical and industrial development of Germany is due largely to the fact that that country, perhaps more than any other, was quick to grasp the value of President Rogers' ideas and, with characteristic efficiency, to build upon them a nationwide system of technical schools and of industrial development.

"As the third category of accomplishment, I would like to suggest simply the present industrial and economic structure of the country. Of course very many factors have entered into this, and the part which the Institute directly or indirectly has played is rather undefined but none the less real and of tremendous significance. Time does not permit elaboration of this interesting theme.

And finally, 'What of the future?' From past experience and accomplishment we may gain wisdom, guidance and encouragement, but it is the future which vitally interests us. In regard to this future there seem to me to be several outstanding considerations.

In the first place there appears to be no reason for any change in the purposes and ideals of the Institute. As I have already remarked, the Institute has been devoted in the most fundamental way to the benefit of mankind through science. There is every indication that only a beginning has thus far been made in the science of discovering and understanding Nature and in the art of usefully applying this knowledge. I can conceive, therefore, of no more appropriate or urgent program for the Institute than simply to continue its work of developing both principles and men for applying science to problems of human welfare. But, although the purpose of the Institute is unaltered, I do believe that present conditions indicate the necessity of careful attention to several vital matters.

First I would suggest the necessity of greater emphasis upon the fundamental sciences both in their own rights and as the bases of the various branches of engineering. As engineering has developed to greater and greater complexities, it becomes increasingly impossible to hope to train men in those exact processes of thought or manipulation for which they will later be called upon. And as scientific discoveries and applications are ever increasing at an accelerated rate, there is ever increasing probability of meeting problems far off the beaten trail. Also many who start in as engineers later become executives or administrators. In all such situations a broad and thorough training in fundamental principles gives much greater power than a training in details which may seldom be encountered in practise. Again, whereas a generation ago most of our great technical industries were in their infancy and needed many men trained in the details of their respective arts, now most of these industries are large organizations which are equipped and prefer to train their own men in the fine points of their art: they absolutely require, however, men who come with a sound basis of training in fundamental principles. The Institution which supplies these men, supplies the men destined to leadership.

(Continued on page 465)

THE TECHNOLOGY LOAN FUND

Official Announcement of the Methods and Policies To Be Followed in the Administration of the New $4,200,000 Fund

THE Technology Loan Fund, the creation of which was announced at the final banquet of the All-Technology Reunion on June 7 by Gerard Swope, '95, constitutes one vital element in the Institute's comprehensive plan for meeting the ever mounting costs of a technical education. It will be at once evident that the Loan Fund is not merely a proposal for aiding needy students but a pioneer idea whereby the increased financial needs of an institution such as Technology may be provided for without periodic resort to endowment fund campaigns. Through the establishment of the Loan Fund, the increased tuition charges which become effective in September, 1931, will not constitute an unsurmountable barrier to students of ability and promise but limited financial means.

In his statement that already over $4,200,000 had been subscribed, Mr. Swope said in part:

"For some time a committee of the Corporation has been working on the problem of increased pay for the teaching staff and increased facilities for research work, both of which are necessary for such an institution if it is to maintain its preeminent position and attract to it the best teachers and students.

"After careful consideration, it has been decided to increase the tuition gradually to a point more commensurate with the cost of education. Tuition at the Institute a few years ago was $300 per year. It was then increased to $400 per year, and in September, 1931, will be increased to $500 per year, as was announced some months ago. The cost of education of the student, depending on what is included in this item of cost, is between $700 and $900 per year.

"To increase tuition without at the same time making provision for students who have not sufficient means to take advantage of the education offered by the Institute, would be tragic. The plan adopted to meet this difficulty is that a loan will be made to any student who passes the required tests of ability, character, and personality, for the amount of the tuition, either in part or in whole. . . .

"To accomplish this, a few members of the Corporation and Alumni were appealed to to create an adequate loan fund, and each one has given the plan his hearty endorsement. Although only a few have been approached, upwards of $4,200,000 has been subscribed. This amount is to be paid over a ten year period. The operation of the

Keystone

CHARLES HAYDEN, '90, SENIOR PARTNER OF HAYDEN, STONE, AND COMPANY WHO CONTRIBUTED TO THE LOAN FUND AND IS CHAIRMAN OF THE COMMITTEE ON THE FUND

GERARD SWOPE, '95, PRESIDENT OF THE GENERAL ELECTRIC COMPANY, WHO CONCEIVED AND COLLECTED THE FUND AND LIKEWISE CONTRIBUTED TO IT

plan will begin in the fall of 1930, and today almost $500,000 has been paid into the loan fund. This amount, in addition to the loan funds already available at the Institute, will provide ample means for an experiment of a comprehensive character in financing modern education more largely from the students receiving the benefits thereof. . . .

"In addition, of course, are the generous provisions at the Institute for scholarships and fellowships for meritorious academic work. [Undergraduate scholarships available for the academic year 1930–1931 total $92,590; graduate scholarships are in excess of $37,000.]

"The subscribers to the Technology Loan Fund so far are: George Eastman, $500,000; Charles Hayden, '90, $500,000; Alfred P. Sloan, Jr., '95, $500,000; Edwin S. Webster, '88, $500,000; John E. Aldred, $250,000; Coleman duPont, '84, Irénée duPont, '97, Lammot duPont, '01, and Pierre S. duPont, '90, jointly, $1,000,000; Charles A. Stone, '88, $250,000; Gerard Swope, '95, $250,000; Franklin A. Park, '95, $150,000; Frank L. Dame, '89, $100,000; Albert G. Davis, '93, $50,000; Charles Neave, '90, $50,000; William C. Potter, '97, $50,000; an Alumnus of the Class of 1894, $50,000; the late William E. Nickerson, '76, $10,000."

Mr. Swope further announced as the committee on The Technology Loan Fund, of which Mr. Hayden has consented to serve as Chairman: Dr. Samuel W. Stratton, Chairman of the Corporation, and President Karl T. Compton, *ex-officiis;* and Messrs. Aldred, P. S. duPont, Swope, and Webster, all of whom are Life Members of the Corporation. This committee hopes that the Fund will be increased above the amount already subscribed and would be glad to receive contributions from Alumni or others interested in its objective.

The interest of President Compton in the plan is manifest by the fact that he is also to serve *ex-officio* on The Technology Loan Fund Board, which is to consider and act upon applications for loans. The other members of this Board are: Bursar Horace S. Ford, Assistant Bursar Delbert L. Rhind, Professor James L. Tryon, Director of Admissions, with Dean Harold E. Lobdell, '17, as Chairman.

At its first meeting the Board adopted the following general rules for the administration of the Loan Fund.

"It will be the general policy of the Board to make a loan only to a student who has completed at least one year of residence at the Institute with a good academic record. Only in *exceptional* cases will applications be considered from a student after one semester of residence and only in *very special and unusual* cases from entering students who have met, with high standing, all entrance requirements.

"The maximum amount loaned to an individual in a single year shall not exceed the tuition fee, less any scholarship grant, or other award, from Institute funds.

"To receive favorable consideration an applicant must:

"1. *Be endorsed as to character and personality by:* (a) *an alumnus of the Institute from the community in which he has resided, or by some other citizen of standing in that community;* (b) *the Principal or Head Master of the high school or preparatory school, or the President or Dean of the college or university he has previously attended;* (c) *his Registration Officer or the Head of the Course in which he is enrolled.*

"2. *Have passed with a standing satisfactory to the Board, the physical examination required annually of all Institute students.*

"3. *Submit a statement of his financial needs and such other information as the Board may deem necessary, on an application form to be supplied by the Board, such application to have the approval of his parent or guardian.*

"A recipient of a loan will be required to sign promissory notes in $50 units up to the amount of his loan, each note carrying interest at two per cent per annum from the date of its issue to a date not exceeding two years after he leaves the Institute, and at five per cent per annum thereafter. Interest is to be paid semi-annually. Each note shall have a definite maturity, such maturities to be spaced at intervals of six months, beginning on or before the December thirty-first following the recipient's expected date of graduation, but payments may be anticipated.

"Upon signing notes, the student will be supplied with copies thereof, and also with a photostat copy of the statements made by him in his application form. After leaving the Institute he will be required to advise the Board annually, or at more frequent intervals, as to his whereabouts, the character of the work in which he is engaged, the remuneration he is receiving and his plans for the repayment of his obligations to the Loan Fund."

THE REUNION IN JUNE

3000 Registered, Including 1300 Guests and 1700 Alumni
Only 2600 Registered in 1925

By Robert E. Rogers

I SUSPECT that towards the end of Friday everybody was looking forward to Saturday with some dread, everybody, that is, who had braved the heat of the Institute laboratories, the sun at the Inauguration, and sweltered in the various hotels and clubs at the class dinners that evening. It was undoubtedly the hottest day Technology had ever suffered at a reunion, certainly back to and including 1916. The proceedings down harbor in 1925 were warmish and, thanks be, Saturday turned out to be no more than warmish; in fact when the day broke there was an east wind that prophesied rain. But the clouds wore off and the day turned out splendid.

Although the buses from the various hotels and the Institute arrived at Swampscott by the middle of the morning, large numbers drove down in smaller groups and nothing much got under way before noon. The die-hard sports went off golfing as soon as they arrived, there was a morning yachting trip and another in the afternoon, but most of the crowd preferred to hang round the broad verandas of the New Ocean House and congregate in the lobby on the lookout for newly arrived classmates and their wives, or to sit round on the rocks and look at the water, of which there was quite a good deal. There was obstacle golf for those who simply can't bear to be inactive and itinerant photographers to show you how little you look as you think you look. In short, the gathering hour was such a pleasant lazy affair that there was considerable difficulty in rounding up enough people for the grand parade which was to integrate the crowd and get them hungry for lunch.

M. I. T. Photo

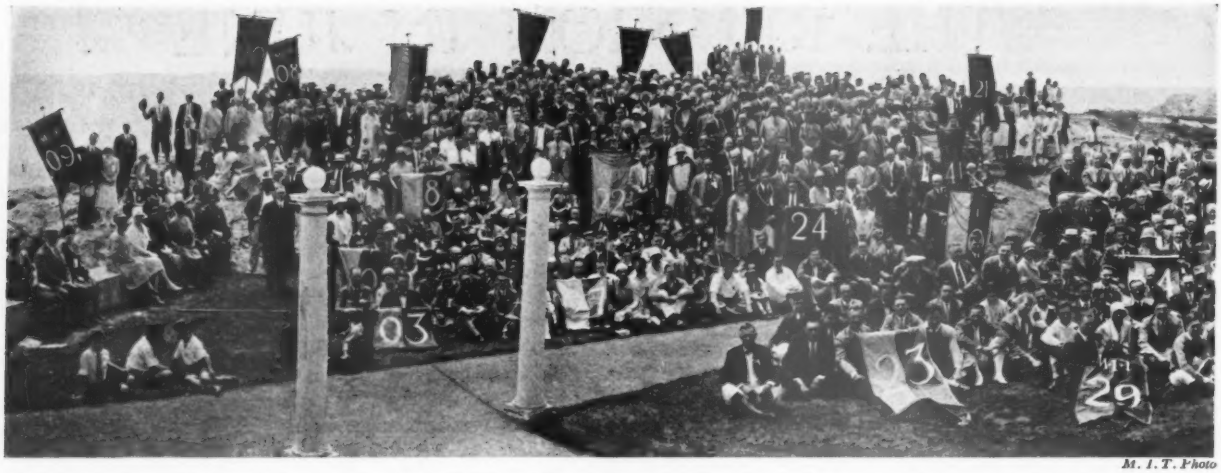
CLASS PARADE AT SWAMPSCOTT OUTING

But presently the banners were being unrolled and the little groups gathering under them, and Marshal Harry J. Carlson, '92, chairman of the Outing started the march heading the most futile amateur apology for a band this scribe has ever seen at an All-Technology Reunion. If I remember correctly this is the only outing when there hasn't been a real band. We needed one badly — all day long. Curiously enough, as soon as the procession got under way it developed unexpected proportions, and by the time it had marched round the miniature golf course of the hotel and gone into a kind of grand march effect on the grounds in front, it was a very respectable procession. The banners of the early classes were borne often by the only class representative. Bobby Richards in ceremonial white insisted on carrying his till it was taken away from him.

The costume part of the procession was a bit meager. Technology doesn't take kindly to dressing up, apparently, but Ninety-Five made a brave appearance in blue smocks and orange berets and Twenty-Six, which adopted your scribe, wore white paper clowns' caps and black paper ruffs, which came off on the neck giving a wearer the appearance of either Amos or Andy half made up for a personal appearance. After the crowd had been massed on the rocks, Doctor Stratton and President Compton arrived, were duly cheered and photographed with the gang, and disappeared, to be seen no more till that evening. The group picture, taken by the Technology Photo Service, presented a massed and noble appearance.

Then everybody broke ranks for the food, which was served on the upper floor of the New Ocean garage, a few miles down the back path, and everybody stood in line for a half hour or so under the sun while being admitted a dozen at a time through a single door. The management of the hotel, in this respect, seemed a little more cagey than hospitable. It would have been perfectly easy to have a double set of serving tables and open both halves of the door. It might even have been possible to provide a few tables and chairs within the hall. And the difficulty which guests, who had taken half their lunches out on the grass, had in getting back inside again for their ice-cream and coffee testified to the scrupulous accuracy of the management's arrangements. Both in 1916 and 1925 far larger numbers of people were fed more easily, rapidly and hospitably than under the arrangements adopted by the New Ocean House. The food was all right.

After lunch and reasonable time for digestion things began to happen in a very pleasant, easy, go-as-you-please way. Bobby Richards was on the job all morning and in the afternoon as well at his pet hobby, the archery grounds, where he and his aids had set up a dozen stalls and a half dozen targets at an easy distance, where the dubs, the amateurs, and those people who do very well the first time they try it, might try their hands at shooting. One of the pleasantest pastimes of the day and well



M. I. T. Photo

WHILE INAUGURATION DREW THE LARGEST NUMBER OF ALUMNI AND ACCOUNTED FOR THE HUGE REGISTRATION, MORE THAN 1000 ATTENDED THE OUTING

patronized. There was a putting match for those who think that day lost that doesn't get in some practice. There was bridge inside for the ladies, but the scribe didn't see many people playing. Perhaps they stopped when he wandered by. And the athletic department of the Institute furnished three very interesting events by undergraduates: two wrestling matches very well fought, a nice exhibition of difficult tumbling by husky members of the gym team, and three rapid and intelligent boxing matches. These lasted until the bus-call came at four o'clock and the party broke up without the promised announcement of the winners in the various events. By half past four nearly all had left the hotel and were on their way back to town to rest and refresh themselves for the evening's events. All in all, the Alumni Association has had larger reunion outings, but also a good deal more strenuous and tiring ones. But this was quiet and easy and friendly and gemüthlich and everybody seemed to be having a nice time.

M. I. T. Photo

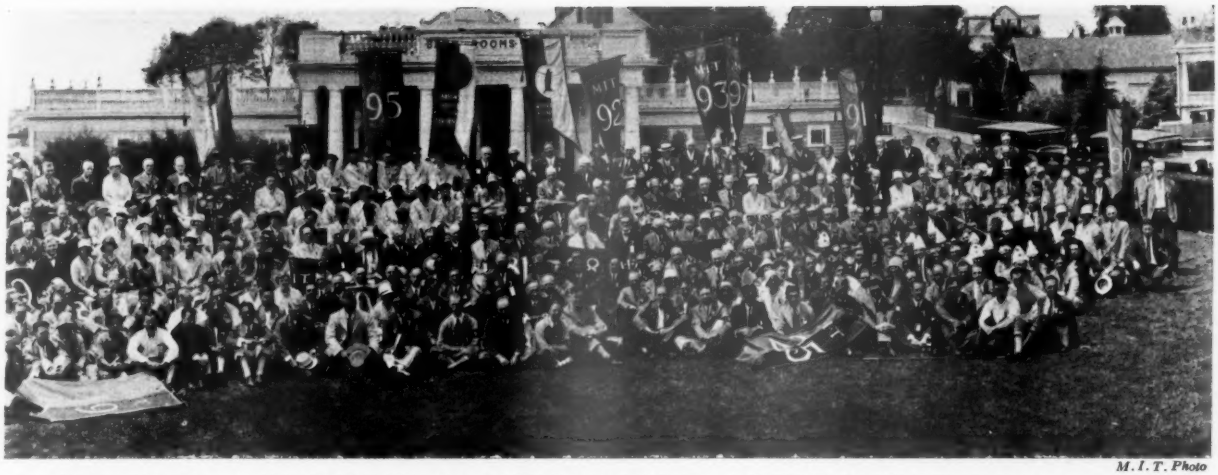
DR. STRATTON, DR. COMPTON, AND CHAIRMAN DESMOND

TIME out from 4:30 P.M. to nearly nine o'clock. During this time your scribe went home, washed up, attended the dinner of the Class of 1930 at the University Club and arrived, in company with the larger part of the Class, at the Statler a little before nine, to find the waiters still removing the tables in preparation for the speaking. It was obvious that the Alumni Association, staging one of these occasions, has outgrown any hotel in Boston, since every reservation was taken, over thirteen hundred, without the 300 or more seniors who came in as I did.

In spite of the heat and the jam I think everyone who was present will agree in saying it was an extraordinarily beautiful and dignified affair, in the grand manner. The 1916 dinner at Symphony Hall was larger and more gorgeous in some ways, but that is natural. The 1925 dinner was just a fine, big, noisy, shirt-sleeve kind of get-together, with lotteries of dogs and auto tires and ocean-trips and electric ice-boxes and automobiles, a nice loud time, slightly rowdyish when the younger class-men were trying to jolly the girls into giving them more than their allotment of safety-razors, and very good fun. But this dinner at the Statler, the crowning event of the Reunion, was very fine and impressive. The Technology crowd and their women never looked better; the decorations were simple but effective, the crowded boxes dressed the scene, and the head table was never longer and never more distinguished. Everybody of importance, it seemed, was there.

I arrived too late to hear the very interesting exchange of radio-telephone messages between Mr. Desmond and Captain A. R. Brooks, '17, in an airplane several thousand feet above New Jersey and, later, including J. G. Chaffee, '23, from the *Leviathan* at sea. The Review is printing more about that on page 450. It must have been worth hearing.

The entertainment began with one of the most amusing and interesting stunts ever pulled off at a Technology meeting, famous



M. I. T. Photo

THIS OUTING GROUP OF 1000 GREW TO MORE THAN 1300 FOR THE CLOSING BANQUET — NOT COUNTING SEVERAL HUNDRED 1930 GRADUATES WHO APPEARED AFTER DINNER

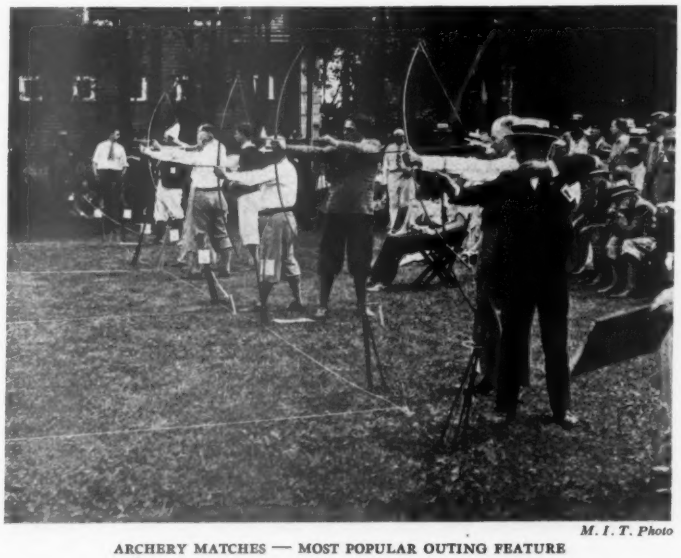
for novel scientific stunts. John Bellamy Taylor, '97, from the Schenectady laboratories of the General Electric, a slender and self-possessed gentleman with a dry wit, gave an exhibition of what he called "narrow-casting," *i.e.* audible light in action. Your scribe didn't understand it all, but he gathered that it had something to do with selenium and photo-electric cells and the process by which moving pictures become talkies. That ought to be enough for the erudite crowd that reads this sheet. But even if you didn't understand it, it was fun to watch and hear. Mr. Taylor showed us the different sounds made by lighted matches and candles and cigarette lighters and thrown out at us by a loud speaker. Then he hitched up some crooked quartz tubes and showed how light can turn corners and loop the loop and still have energy enough to make funny noises. Then he tied a dim bulb to a soundless phonograph and made it play tunes, made different kinds of currents play different tunes, and generally played hob with what an amateur has always considered the laws of probability. He ended by broadcasting his own voice from a beam of light through a revolving film and retired to tumultuous applause.

The speaking, with Thomas C. Desmond, '09, as toastmaster, was admirable. Every speech clicked. None was long, all were interesting. The first was an eloquent tribute by Charles C. Peirce, '86, to General Coleman duPont, '84, unable to be present because of illness, and the dispatch of a telegram of affection and good hopes by the Association. Then Professor Harry W. Tyler, '84, departing this year after nearly fifty years of connection with the Institute, made one of his typical little speeches, with the finest voice in the Institute, simple and sincere but exquisitely phrased and vibrant with feeling. He too was cheered to the echo. Dr. Stratton spoke briefly on the connection between the Institute and science and industry and forecast great developments for Technology in the world of pure science.

President Compton spoke also briefly, carrying on the theme opened by Dr. Stratton and announcing the immediate building of a new wing for physics and chemistry. He also told a very welcome funny story or two.

The evening was climaxed by Gerard Swope, '95, of the Corporation who told at length and with much feeling the story of raising the fund of over four millions, to provide Technology students with loan funds. See page 439 for a complete description of this Fund. A most interesting and human sort of speech, full of generous tributes to the men, mostly of the Corporation, whose gifts have made this loan fund possible, including Mr. William E. Nickerson, '76, whose funeral had been held only that day.

The announcement was a worthy conclusion to a very successful Reunion (and a very large one, counting the Alumni who attended the inauguration only). Never has the Stein Song been sung more feelingly, as the dinner broke up and the day was ended with dancing.



M. I. T. Photo

ARCHERY MATCHES — MOST POPULAR OUTING FEATURE

BOOKS

Physics Explained and Unexplained

THE NEW WORLD OF PHYSICAL DISCOVERY, by Floyd L. Darrow. $3.50. 371 pages. Indianapolis: *The Bobbs-Merrill Company*.

SINCE the rise of relativity a score of books have been published which attempt to explain in plain language the problems and results of modern physics. Einstein himself has written an elementary presentation of his theory, and some of the most outstanding scientists, Max Born, Eddington, Jeans, and Bridgeman, have given us excellent books on the subject.

In spite of this fact it seems today obvious that the average educated person has not even the slightest idea what it is all about. Judging from newspaper articles and from speeches given by educators, lawyers and clergymen, it appears rather hopeless to make the average intelligentsia acquainted with the results of the most fundamental of all sciences. These various comments prove that even persons with college education are unable to master the elementary high school calculus involved in these books, that they cannot grasp the logic of the physicists and do not appreciate the value of their discoveries.

This situation can partly be explained by the fact that most people are not familiar with the elementary laws of classical physics, and it is evidently useless to teach the modern theories to anybody who does not know the work of Newton, Huyghens and Faraday. Like all scientific knowledge, physics can only be understood if one knows its history. Our present viewpoint is the result of the investigations, ideas, and mistakes of the pioneer scientists, and it is most probable that our ideas about matter, light, and heat would be quite different, if the historical developments would have taken a different course.

F. L. Darrow's book presents a new attempt to acquaint the general reader with the salient features of modern physics. The author's name does not appear in the list of great physicists. But this statement does not mean that the author is not qualified to write a book on physics. If a physicist writes a book he is like the host who invites a foreigner to his own home; he shows him all the wonderful things, but his explanation is in a language unknown to the guest. Darrow evidently does not show you his own house; he is a guide who knows the language of the visitor. Consequently, his book differs widely from previous publications on the subject.

Realizing the deficiencies of the average person the author devotes one half of the volume to the history of classical physics. This first part of the book is excellent. The author has a rare gift for describing the life, the ideas, and the experimental work of the great founders of physics. This part will wake in every reader enthusiasm and admiration for the wonderful instinct, the toilsome experiments, and the modest character of these early research workers. The first five chapters present fine pictures of how the different parts of physics were developed, how knowledge grew, how each generation has stood on the shoulders of its predecessors. We see step by step how the edifice of classical physics was built, first mechanics, then the theory of heat, the theory of electricity, magnetism, and light.

This part of the book is a masterpiece. Among all the important physicists, whose life and work are shown in an admirable manner, we miss, however, the names of two, Boltzmann and Gibbs. These two great scientists should certainly be mentioned in the chapter on heat, and it is rather surprising that they are left out, since the author emphasizes in the other parts of the book in particular, the contribution of American scientists, among whom Gibbs is certainly one of the greatest.

The second half of the book describes the rise of modern physics, the theory of the electron and the atom, the birth of the light quant-hypothesis, the fall of classical mechanics. Also here the historical presentation is very clear, and interesting. The conflict between these new discoveries and the classical ideas is very clearly emphasized. The author attempts to explain the present state of affairs, the new mechanics of Einstein, the general theory of relativity, and the problems of atom physics. He trys to explain it without any mathematical formula. The result is, however, not satisfactory. I do not believe that the chapter on "Relativity for Everybody" will satisfy any critical reader. It does not contain any false statements, but fundamental facts are not mentioned. The fundamental fact on which special relativity is based is evidently that our most accurate experimental determinations of time (simultaneity of two events) and length are made with the help of light, and generalized relativity is based on the observed fact that inertial and gravitational mass are equal. Neither of these two facts are explained. The chapter on Atommechanics entitled "A Topsyturvy World" is not up to date. It describes the state of the problem as it was about two years ago. The work of Heisenberg has changed the situation since considerably. Curiously enough his name is not even mentioned, while the work of other investigators, whose papers have been published after Heisenberg's important contribution, is fully reported.

As a whole the book can be recommended. The reader will find it enjoyable and interesting, and he will learn a little more "what it is all about." But he will be disappointed if he expects that it will lift the veil of mystery surrounding the theory of relativity and atom mechanics.

HANS MÜLLER

The Revolution

CHARACTERS prominent at the time of the American War of Independence, men whose names to posterity signify contrasts ranging from the rôle of hero to that of traitor, appear in the current lists (*Continued on page 466*)

THE TREND OF AFFAIRS

Gas

WILLIAM MURDOCH ran a small experimental gas plant in 1795, lighted a Soho factory by gas a few years later, and in 1808 was awarded the Rumford Medal of the Royal Society for his invention. The Gas Light and Coke Company was incorporated in London in 1812. In Baltimore, gas lighting got its start in the United States on June 17, 1816, when the city council passed an ordinance permitting Rembrandt Peale, not only to continue lighting his museum by gas, but to manufacture gas in quantities, lay pipes in the streets, and contract with the city for street lighting.

Electricity's advent, 60 years or so later, spelled the doom of lighting revenues to the gas industry, although temporary relief came about through securing most of the urban cooking load of the country. But, compared to other utilities, the gas people slumbered for years, notable for their unwillingness to adopt progressive practices. However, what has been accomplished since 1900 and, most strikingly in the natural gas industry within a decade, points to an encouraging future. Sales in the manufactured gas industry in this country have mounted annually for 25 years to quadruple what they were, but natural gas production has moved from 662,000 million cubic feet in 1921 to 2,000,000 million in 1929.

New York Telephone Company

"TECHNOLOGICAL TENUOUSNESS" — UNDERGROUND TELEPHONE CABLES IN NEW YORK AFTER A SUBWAY FIRE

Creation of new uses for gas — in mechanical-refrigeration, for domestic heating of water and of houses and apartments, and in manifold industrial operations — accounts for acceleration of demand. Interconnection of small plants to eliminate wasteful and obsolete producers, cutting down overhead and obtaining diversity of load, and the transportation of gas under compression through long distance pipelines, have made it possible to keep pace with the demand.

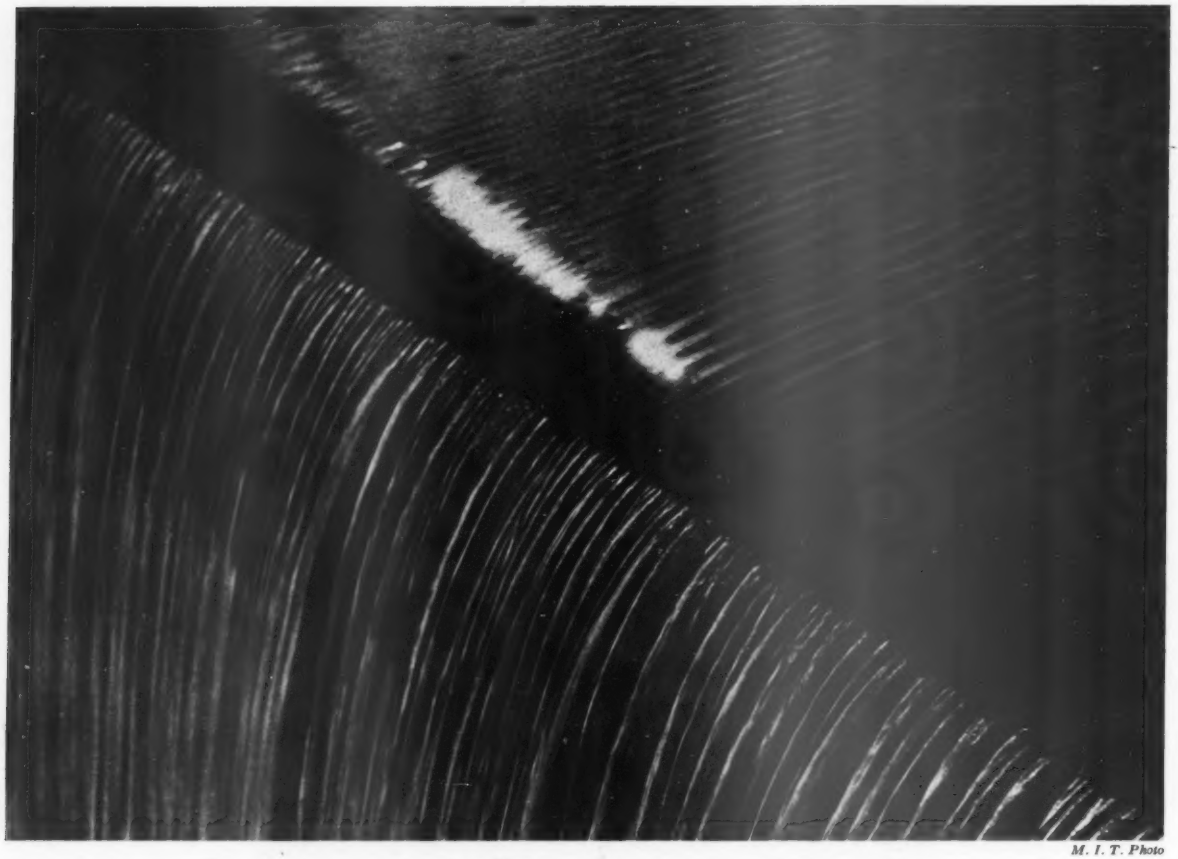
Pipelines are a most important factor in the development of the natural gas industry, and three-fourths of the United States recognizes natural gas as a dominant form of fuel. Its comparative cheapness combined with the ease by which its heat can be controlled, the fuel storage space it frees for other uses, the liberation of capital hitherto tied up in coal piles, the elimination of smoke and ash, make natural gas especially popular with industrial users.

Trunk and subsidiary pipelines in the United States now total nearly 200,000 miles, the longest present transmission being from the Louisiana fields to Birmingham, Alabama, and Atlanta, Georgia — 469 miles. This system with lateral lines totals nearly 1,000 miles and it includes six separate lines at the bottom of the Mississippi to prevent any possible interruption of service. The change-over of burners in Atlanta where manufactured gas had been in use 75 years, involving as it did nearly a million separate operations (for five to eight burners must be changed on each gas range), illustrates a single minor phase of this stupendous operation.

From the Monroe-Richland field of Louisiana, natural gas is now being pumped 447 miles to St. Louis, crossing 15 rivers on the way; from the Texas Panhandle, 350 miles to Denver; from the San Joaquin Valley, 250 miles to San Francisco; from Wyoming, 290 miles to Salt Lake City and Ogden. Still larger projects are contemplated: from the Texas Panhandle to Chicago and adjoining areas, 1,250 miles, and others.

Present lines are from 14 to 24 inches in diameter and the development of steel pipe has made them capable of withstanding 300 to 600 pounds per square inch pressure. Improvements in manufacturing, laying methods, and ways of preventing corrosion make it possible that pipelines can now be constructed for less money than electrical transmission lines of equivalent energy capacity. The effect on public health can be imagined when it is estimated that smoke and soot are now accountable for a deposit of 460 tons annually on a square mile in Chicago.

Some apprehension exists as to what will become of the vast sums buried in pipelines if the supply of gas is exhausted. To this *Power* replies: "Processes are even now in the making which assure an abundant gas supply. . . . No great stretch of imagination is required to warrant the prediction that pipelines will transmit gas as long as they themselves exist."



M. I. T. Photo

"A CORRUGATED SHEET OF WATER," POURING OVER THE LIP OF A DAM IN NEW HAMPSHIRE

Engineers in Russia

AN ANALYSIS of United States exports to ten foreign countries for the first three months of 1930 shows an increase in shipments to only two countries, Russia and Mexico. The exports to Russia for that period were over three times as large as for the corresponding months of 1929. Since 1924, over 2,000 American business houses have received Russian orders and in 1929 exports increased $54,000,000 over 1928.

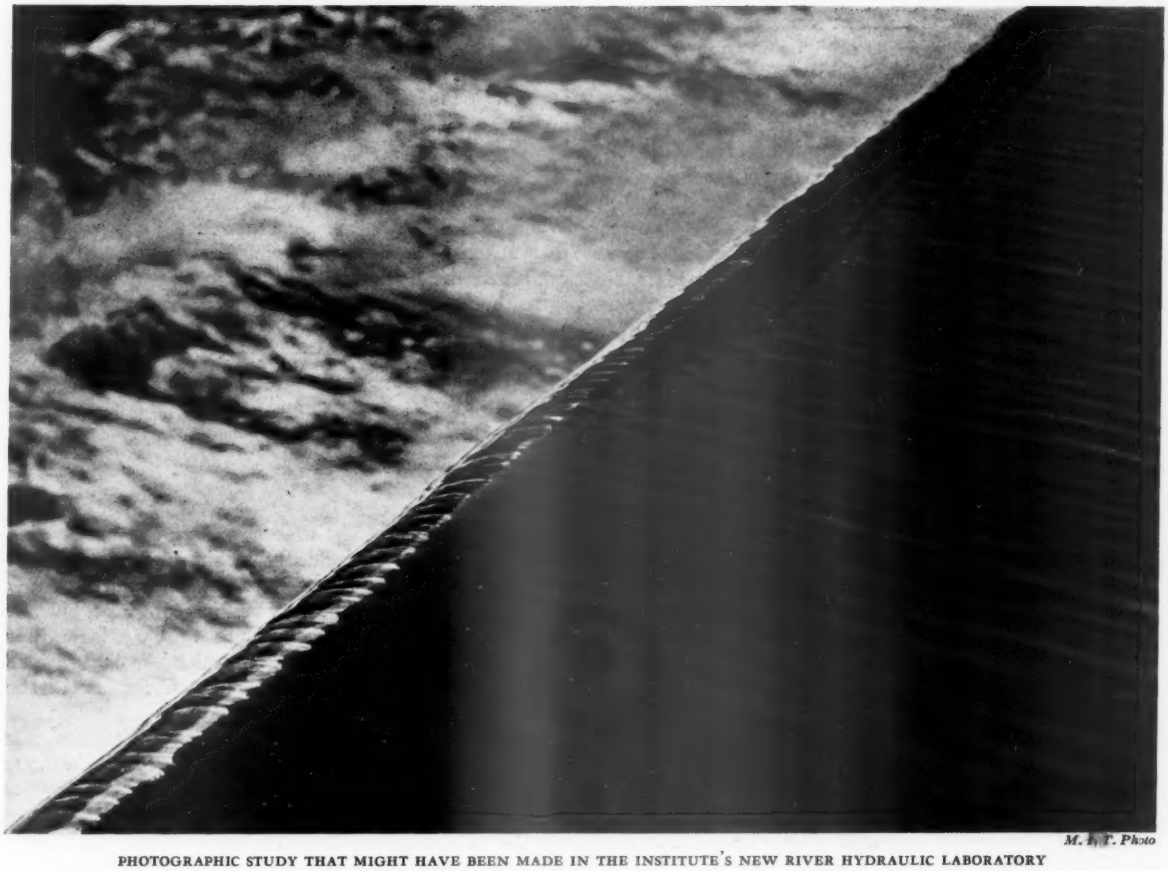
A large percentage of these exports to Russia for the past few years has consisted of turbines, electrical equipment and textile machinery specified by American engineers in the employ of the Soviet Government. Power stations, locomotive works, machine building plants, textile mills, automobile factories, and steel mills are being constructed there according to American industrial principles and under the supervision of experienced American engineers. No doubt the rapid depletion of Russia's finest caviar and her one-time plentiful supply of old French wines is directly traceable to the voracious, if not discriminating, American appetites.

America may well be thankful for this business with the Soviet Government. Considerable slack in American industry which came as a result of the stock market crash of last fall has been partially alleviated by the avalanche of orders placed by the Amtorg Trading Corporation of New York — official purchasing agents for the Soviet Government. Cleveland, a machine tool center, perhaps more than any other city has benefited from this Russian business. The Austin Company with headquarters in that city contemplates the expenditure of nearly $20,000,000 in the United States for materials to be used in building Russia's first model city for the manufacture of automobiles.

The power project being developed on the Dnieper River, under American supervision, will cost $110,000,000. It will require 130 railroad cars to transport the electrical equipment for this single power development. Although Russia has not been recognized politically by America, the American business man and engineer apparently realize the size and the importance of the Russian market and are encouraging its development.

Fog

CABLED DISPATCHES that comprehensive fog studies were being undertaken by the Institute's meteorological station on the estate of Colonel E. H. R. Green at Round Hill, Mass., reached England during the anniversary of the persistent fog of 1902. With the possible exception of residents of the western slopes of the Cascade Mountains in the State of Washington, such an item could excite no greater interest than among Britons poking about in the murk of a Scotch mist, a Dartmoor drizzle, or the atmospheric pea soup of a "London partic'lar." To the story, therefore, English editors gave prominence.



M. I. T. Photo

PHOTOGRAPHIC STUDY THAT MIGHT HAVE BEEN MADE IN THE INSTITUTE'S NEW RIVER HYDRAULIC LABORATORY

Generally speaking, their comment was a mixture of good will and tolerant skepticism. The *Daily Telegraph* felt: "Our own not inconsiderable London experience suggests you may observe a great many fogs without being any forrader in prevention. But the intention of Massachusetts is benevolent." The *Evening News*, while asserting that "time was when we should have hotly contended that London, not Massachusetts, should be the spiritual home of such an institution," promised that, if the studies resulted in dispelling fogs, "London would not begrudge . . . the ensuing honours."

A misstatement in the cabled news report, however, provoked sarcastic and bitter, though restrained, rejoinders. In the announcement given out from Round Hill it was stated that "to the layman fog is simply fog, but the scientist has classified fog in more than a score of forms" (one authority for this being the United States Weather Bureau) and that the Technology station purposed to examine such of these as infested the region of Buzzards Bay. Somewhere in getting overseas from Round Hill to London this modest proposal was revised into a clarion proclamation that Technology had decided "to classify fogs into twenty varieties, which will be studied separately."

Here was something which touched Imperial pride. As one editor conceded, it might be "thoroughly scientific" but British officialdom, in all the fogs it had ever experienced, recognized but five "grades of obscurity." Such impeccable bulwarks as The Meteorological Office, The Admiralty, and The Trinity House vouched that five breeds there were, no more and no less.

"About the time the Battersea Power Station is finished there will probably be twenty-one," flung out the London *Observer;* and the columnist of a contemporary grandiosely boasted, "London's unmistakable varieties run into some hundreds." A third mourned, "Our English groping . . . does not seem to carry us very far."

But it was the Manchester *Guardian* which seemed most affected: "They must have a lot of very hard-working fogs in Massachusetts if they can find twenty separate sorts for examination. . . . Doubtless they will do the thing very well in Boston, Massachusetts. Possibly there will be special intelligence tests for fogs in order to establish their specific density of understanding; young, fluffy little fogs will be handed over to a welfare worker to see what can be done about their future, while old, hard-bitten, double-dyed fogs with thick lumps in them will be psychoanalyzed to find out whether they owe anything of their depravity to inhibitions that got soaked into the system in early childhood."

Television

RECENT laboratory demonstrations may indicate that television in a satisfactory form is just around the scientific corner. Although those who are working to

Bell Telephone Laboratories

HARRY P. CHARLESWORTH, '05, VICE-PRESIDENT, BELL TELEPHONE LABORATORIES, WHO ARRANGED THE NOTABLE EXPERIMENT IN TELEPHONY DESCRIBED ON PAGE 450

project the vision of man through space are cautious in making prophecies, it is apparent much is being accomplished.

In New York the Bell Telephone Laboratories have demonstrated two-way telephone and television communication in which men separated by three miles of Manhattan's towers conversed and saw images of one another as they spoke. Dr. Frank B. Jewett, '03, President of the Bell Telephone Laboratories, was quoted as saying that the conversation and two-way television could just as well have been demonstrated over a distance of 2,000 miles. Several new inventions, he added, made this demonstration possible.

And at Schenectady a few weeks ago the General Electric Company and the Radio Corporation of America joined to demonstrate the first television radio talkie, a laboratory experiment now, but a possibility for the American fireside of the not too distant future. In this demonstration an audience in a Schenectady theatre watched on the screen an orchestra being led by the life-sized image of a conductor who was carrying on his musical gymnastics in a television studio some miles away, whence the music of his musicians was transmitted by telephone.

The performers in this phantom show of science acted before a television camera in the laboratory of Dr. E. F. W. Alexanderson of the General Electric Company. A transmitter operating on a wavelength of 140 meters, converted the light impulses into radio signals. At the same time a microphone registered speech and music and transmitted them by wire to a laboratory in South Schenectady from which they were broadcast on a wavelength of 92 meters. This broadcast was received in the theatre where the light impulses and radio signals were again transformed into the image and the sounds of man.

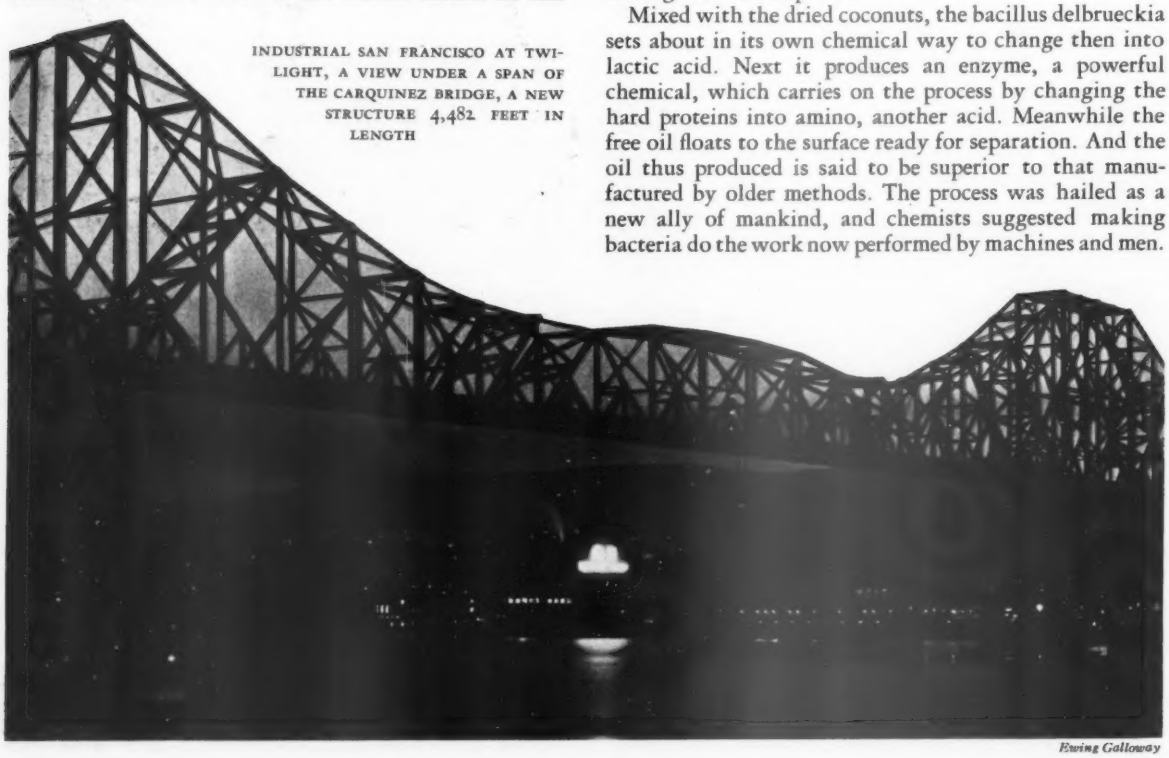
Oil Bacilli

THE unemployment situation among the beer bacilli has taken on a decidedly bright outlook and the prospect is that the germs that once inspired the now illegal brew may soon be busy making, not beer, but oil. All this because of the discovery that the particular beer bacillus called "delbrueckia," obtained from brewer's malt, may replace heavy extracting machinery in the manufacture of oil from dried coconuts.

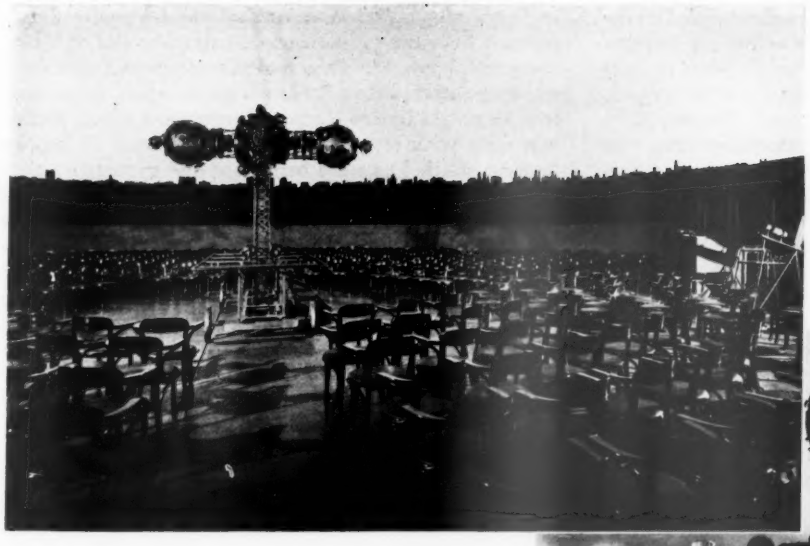
Announcement of the discovery of this process was made by Dr. John Woods Beckman of Oakland, Calif., at the recent meeting of the American Chemical Society at Atlanta. The new process is said to produce nothing in substance or effect to which the most ardent prohibitionist might take exception.

Mixed with the dried coconuts, the bacillus delbrueckia sets about in its own chemical way to change then into lactic acid. Next it produces an enzyme, a powerful chemical, which carries on the process by changing the hard proteins into amino, another acid. Meanwhile the free oil floats to the surface ready for separation. And the oil thus produced is said to be superior to that manufactured by older methods. The process was hailed as a new ally of mankind, and chemists suggested making bacteria do the work now performed by machines and men.

INDUSTRIAL SAN FRANCISCO AT TWILIGHT, A VIEW UNDER A SPAN OF THE CARQUINEZ BRIDGE, A NEW STRUCTURE 4,482 FEET IN LENGTH



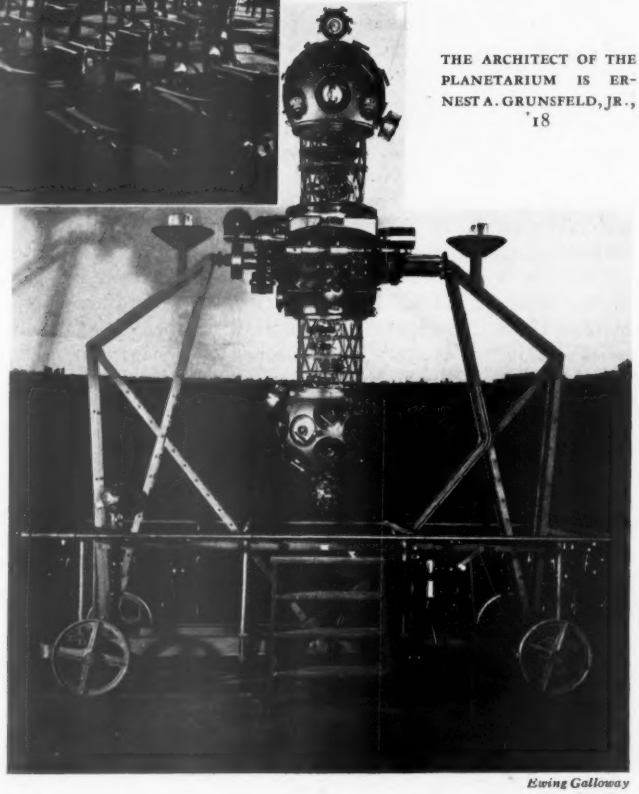
Ewing Galloway



LEFT: INTERIOR OF THE ADLER PLANETARIUM IN CHICAGO, SHOWING THE PROJECTOR IN WORKING POSITION, ELECTRIC CONTROL BOX AT EXTREME RIGHT, AND CHICAGO SKYLINE PAINTED ON THE LOWER EDGE OF THE DOME CEILING

BELOW: PROJECTOR CONTAINING 190 INDIVIDUAL PROJECTORS WHICH PROJECT SUN, MOON, STARS, AND PLANETS ON THE LINEN COVERED DOME

THE ARCHITECT OF THE PLANETARIUM IS ERNEST A. GRUNSFELD, JR., '18



Ewing Galloway

He or She?

RECENTLY an advertising man whose purpose it was to bring a certain giant locomotive of a certain railroad into national prominence, dug deep into his bag of superlatives and from it dragged the names *Leviathan* and *Mammoth*. Having named his engine, he personified it in the masculine gender.

The names or their origin aroused no particular interest. The public remembered a ship called *Leviathan*, and *Mammoth* was reminiscent of the greatest show on earth or the latest talkie, but to call a locomotive "he" was quite another matter. The railroad men, who always have referred to their engines as "she" or "her," precipitated the storm, the controversial breezes of which swept through the country's literary timber. No amount of paid advertising space could have been so valuable as the publicity that ensued.

Authorities on rhetoric and grammar in many universities, librarians, editors, and the public voiced their opinions. The pronoun "he," most of them agreed, was applicable to a locomotive. One, bolder than his colleagues, suggested that the cold and bloodless "it" was the proper term.

Bell Telephone Laboratories

CAPTAIN A. R. BROOKS, '17, WHO LED TECHNOLOGY MEN IN A CHEER, WHILE HE FLEW IN A PLANE. SEE PAGE 450

Mariners always have referred to ships in the feminine gender, for the beauty of line and lofty slender spars of the sailing ship suggest the grace and charm of the feminine. The locomotive, on the contrary, suggests manly attributes. Nevertheless, railroad men have, and probably always will so long as steam turns driving wheels, speak of their locomotives as "she" or "her." As a matter of fact appearances, as in the instance of ships, have nothing to do with their custom. When a railroad man gazes at his engine and says: "She's a great old tea kettle and she'll yank a hundred cars over any grade," he is speaking with pride and out of a great respect and affection for the Iron Horse and all that he, she, or it stands for in the romance of railroad history.

Kipling in his famous story ".007" in which he personifies locomotives, speaks of his hero, an eight-wheeled American type locomotive, as "he," but refers to a compound type engine as "she" in a manner designed to portray a character of less virility. Railroad men, to be sure, have quarreled with Kipling's characterization, but there are few who will deny that their hearts thump a beat faster when they read at the end of that fine tale:

"Now, in the darkest night, even as the *Purple Emperor* said, if you will stand on the bridge across the freight-yard, looking down upon the four-track way, at 2:30 A.M., neither before nor after, when the *White Moth*, that takes the overflow from the *Purple Emperor*, tears south with her seven vestibuled cream-white cars, you will hear, as the yard-clock makes the half-hour, a far-away sound like the bass of a violoncello. . . . That is .007 covering his one hundred and fifty-six miles in two hundred and twenty-one minutes."

Efficient Locomotive

A NEW type of locomotive, equipped throughout with roller bearings which, it is claimed, make oiling necessary only once a year, has been developed by the Timken Roller Bearing Company. This new giant of the rails, for the engine is 102 feet long and weighs 720,000 pounds, has been in test operation on the New York Central Lines between New York and Buffalo. Its performance is reported to have been eminently satisfactory and the locomotive will later be loaned to other railroads for further tests under varying conditions.

The new roller bearing locomotive is said to have shown a saving of 12% in operating costs, and its builders claim it is capable of maintaining a speed of 85 miles an hour under average conditions. Its four driving wheels are 72 inches in diameter and its tender, with twelve wheels, has a fuel capacity of 21 tons, and carries 14,200 gallons of water. The test engine now in operation was built by the American Locomotive Works at Schenectady, and the special roller bearings with which it is fitted were designed by Tracy V. Buckwalter, Vice-President of the Timken Roller Bearing Company.

Cheer Leading from an Airplane

ONE of the most striking scientific features of the All-Technology Reunion Banquet on June 7 was a demonstration in which long distance land telephone communication and radio telephony were combined to bring to the diners the greetings of two Alumni, one flying through the night over New Jersey, and the other on board the liner *Leviathan* some 600 miles east of New York.

The demonstration, aside from its attraction as entertainment, illustrated in a most dramatic manner the achievements of the modern communication engineer. The experiment was arranged by the Bell Telephone Laboratories under the direction of H. P. Charlesworth, '05. Captain A. R. Brooks, '17, a war-time Ace, flying some 1,500 feet over Morristown, N. J., in the company's research plane, played the rôle of a celestial telephone exchange in directing the communication hookup which brought the voice of J. G. Chaffee, '23, also a member of the Bell Laboratories staff, from the *Leviathan*.

Captain Brooks made what to all appearances was an ordinary telephone call to Thomas C. Desmond, '09, Chairman of the All-Technology Reunion, and President-Elect of the Alumni Association, who answered on a telephone installed at the head table. After sending the greetings of Technology men who were unable to be at the dinner, Captain Brooks announced that Mr. Chaffee, on board the *Leviathan*, wanted to say a word, and in a moment his voice came clearly across 600 miles of sea by radio telephony. Mr. Desmond talked with Chaffee for a few moments and then Brooks came on again, suggesting that he would like to lead the Alumni in a cheer. And it was done with resounding echoes, the voice of Brooks leading, while Desmond performed the gymnastics that are part of college yells. The echoes of "We Are Happy," with the usual reference to the limbo of the damned, went back to Captain Brooks in his flying laboratory over the darkened landscape of New Jersey.

Installed in the plane was a Western Electric radio receiver and transmitter, the latter rated at 50 watts output. Captain Brooks spoke into a microphone provided with a housing which fitted closely against his face to shut out engine and propeller noise. From the plane the conversation passed by radio to and from the Laboratories' ground station at Whippany, N. J., whence it proceeded by long distance wire circuits of the American Telephone and Telegraph Company to Boston and into the banquet room.

The *Leviathan's* radio equipment, also a product of Bell Laboratories, is that regularly used for ship-to-shore telephony. From the ship, transmission is to a radio receiver at Forked River on the Jersey coast, and by wire lines to the long-distance office in New York. In the opposite direction, land lines are used from the long-distance office to a radio transmitter at Deal, N. J. The ship circuits were connected at New York to the Whippany-Boston circuits used for the airplane conversation between Messrs. Desmond and Brooks.

Bell Telephone Laboratories

INTERIOR OF PLANE USED IN THE RADIO-TELEPHONY EXPERIMENT DESCRIBED ON THIS PAGE

THE INSTITUTE GAZETTE

New Physics Head

ONE of Dr. Compton's first acts after his inauguration as President was his announcement that Professor John C. Slater of Harvard University is to be the new Head of the Department of Physics at the Institute, succeeding Professor Charles L. Norton, '93, who will in the future devote himself to the administration of the Division of Industrial Coöperation and Research. Professor Norton has long been the moving spirit of the Division and its great usefulness is largely attributable to his policies and ideals.

Bachrach

DR. JOHN C. SLATER, OF HARVARD, NEW HEAD OF THE DEPARTMENT OF PHYSICS

Professor Slater, although a young man (he was born in 1900), has a distinguished record in both this country and abroad. Primarily a theoretical physicist, he has also carried out experimental researches and has been particularly interested in the coördination of experimental and theoretical work. He received his A.B. from the University of Rochester, and his Ph.D. in Physics from Harvard in 1923. His research for a doctorate on the compressibility of the alkali halides was carried on under Professor P. W. Bridgman.

During the following year he studied in Europe on a traveling fellowship from Harvard, spending part of the time in Cambridge, England, and later working with Professor Niels Bohr at Copenhagen. He returned in 1924 to become an instructor at Harvard and there he remained teaching, doing research work in the quantum theory, and becoming successively an assistant professor and associate professor.

In the summer of 1926 he taught at Stanford University and in the summer of 1928 at the University of Chicago. Last year as a Guggenheim fellow he worked in Europe for a time at Zurich and later at Leipzig with Professors Heisenberg and Hund.

In announcing the appointment President Compton said: "This move is being made with the complete approval of the Harvard physicists as opening the way to increased coöperation between the physics departments of the two institutions in building up a great center of physics in Cambridge. . . .

"When the new laboratory for research in physics and chemistry is built, which will probably be within a year and a half, there will be opportunity at the Institute for a great development in physics and chemistry, which are fundamental to practically all branches of engineering. The Institute is very fortunate to have Professor Slater's leadership in the physics portion of this program."

New Department

AMONG the most enduring accomplishments of the Alumni Council may be included its recommendation presented to the Corporation in 1913 that "a new course be established whose aim shall be to furnish a broad foundation for ultimate administrative positions in commerce and industry by combining with a general engineering training instruction in business methods, business economics, and business law." In accordance with this report, the Faculty of the Institute at the request of the Corporation established the Course in Engineering Administration which graduated its first class in 1917.

In only a few years Course XV grew to be one of the largest courses at the Institute and this past academic year it had an enrollment of 298 students. The members of the Council who were sufficiently foresighted to conceive of such a Course and bring about its creation have seen their efforts bring forth fruit richly and only recently they received additional testimony of the value of their work when Dr. Stratton announced that the present Course is to be established as a Department of Business and Engineering Administration.

This move by the Institute signifies a recognition of the great success and usefulness of Course XV, and is a move to broaden the opportunities in that field at the Institute.

The establishment of the new Department becomes effective at the beginning of the academic year next autumn. It will offer, in addition to the undergraduate courses leading to a B.S. degree, graduate courses permitting a student holding an engineering degree from an accredited institution to obtain a Master's degree in Business and Engineering Administration by completion of work given in a summer session and in a subsequent graduate year.

Erwin H. Schell, '12, Professor of Business Management, is to be Acting Head of the Department for the forthcoming year. Professor Davis R. Dewey who has been in charge of the Course in Engineering Administration remains the Head of the Department of Economics and Statistics.

The new Department will be sponsored by an advisory committee composed of eminent financiers and industrialists, many of whom are members of the Institute Corporation. The list included Victor M. Cutter, President of the United Fruit Company; John R. Macomber, '97, President of Harris Forbes and Company; Francis W. Fabyan,

WILLIAM EMERY NICKERSON, '76, WHO DIED JUNE 5. HE FOUNDED AND ENDOWED THE CHAIR OF HUMANICS AT THE INSTITUTE AND WAS A MEMBER OF THE CORPORATION

'93, of Bliss, Fabyan and Company, Boston; Alfred P. Sloan, Jr., '95, President of the General Motors Corporation; Charles A. Stone, '88, Chairman of the Board of Stone and Webster, Incorporated, and Gerard Swope, '95, President of the General Electric Company.

Commencement

TECHNOLOGY'S sixty-third graduation exercises were held in Symphony Hall on June 10, an event marked by the presence in undiminished vigor of Professor Emeritus Robert Hallowell Richards, a member of the Institute's Class of 1868, the first graduated from Technology, and of which three of the original 70 are active and living.

Of the total of 584 degrees awarded at commencement this year, 203 were for graduate honors, including 9 Doctors of Philosophy, 19 Doctors of Science, one Doctor of Public Health, 7 Masters of Science in Architecture, 163 Masters of Science in various other classifications, and four Certificates in Public Health. There were 381 Bachelor's degrees.

The commencement address was delivered by Sir William H. Bragg, one of Great Britain's most distinguished scientists, the Director of the Royal Institution, and with his son W. L. Bragg, winner in 1915 of the Nobel Prize for a study in x-rays and crystals. He spoke to the graduating class on the development of scientific curiosity, the dawn of the urge to know more about nature; of the evolution of scientific investigation that has led to great discoveries.

Again, as often in the past, the familiar figure of Alexander Macomber, '07, marched at the head of the long academic procession as Chief Marshal. With him walked Dr. Stratton and then President Compton; Sir William Bragg; Frank L. Locke, '86; the Rev. Dr. Russell H. Stafford, who gave the Invocation; Professor James R. Jack and Admiral Philip Andrews; Major Robert Arthur and Brig. Gen. William E. Cole; Professor Carroll W. Doten, escorting the representative of the City of Boston; Mayor Richard M. Russell of Cambridge, escorted by Professor Floyd E. Armstrong; Professor William Hovgaard and Captain Schlabach, and Professor James F. Norris, Chairman of the Commencement Committee.

Walter Humphreys, '97, Secretary of the Corporation, led the division of the Corporation members, among whom were Gerard Swope, '95, Everett Morss, '85, William S. Forbes, '93, Charles T. Main, '76, William R. Kales, '92, Harry J. Carlson, '92, Frank W. Lovejoy, '94, Henry A. Morss, '93, Albert F. Bemis, '93, Roger W. Babson, '98, and William H. Bovey, '94.

Professor Samuel C. Prescott, '94, Chairman of the Faculty, led the Class of 1880, the Fifty-Year Class, which had a place of honor in the procession. Those members of the Class who marched were William L. Benedict, William C. Bond, Arthur P. Abbott, Professor George H. Barton, Henry D. Winton, and Mrs. Louise Ordway Tead. The faculty marshal was Professor George E. Russell, '00, who led the division at the head of which marched Professor Allyne L. Merrill, '85, Professor Robert H. Richards, '68, and the oldest living graduate of the Institute; Dean Harold E. Lobdell, '17, and Professor Dwight Porter. Following the Faculty came the long line of candidates for degrees.

Following Commencement exercises, Dr. Stratton was host at a luncheon at his home on Charles River Road for members of the Fifty-Year Class. In addition to the members of the Class of 1880, other guests were Dr. and Mrs. Karl T. Compton, Sir William Bragg, and Miss Bragg, Dr. and Mrs. Prescott, and Professor and Mrs. Jack.

146th and Annual Council Meeting

ON MAY 12, the 146th and Annual Meeting of the Alumni Council was held in Walker Memorial with fifty-three members and guests present. As this was the last meeting for the present fiscal year, the entire agenda of the evening, with one exception, was devoted to the reports of the officers and the committee chairmen. Harold B. Richmond, '14, Vice-President of the Alumni Association presided and as usual carried out the business of the evening with admirable dispatch and relieving humor.

Godfrey L. Cabot, '81, William D. Coolidge, '96, and Redfield Proctor, '02, were announced as the choice of the Alumni Association for nominees for Term Members on the Corporation.

Election of the following officers of the Association for the next fiscal year commencing July 1, 1930 was also announced: President (for one year), Thomas C. Desmond, '09; Vice-President (for two years), Donald G. Robbins, '07; Executive Committee (for two years), Raymond S. Stevens, '17, Henry E. Worcester, '97;

Representatives-at-Large (for two years), James I. Banash, '06, W. Rawson Collier, '00, Robert J. Marlow, '17, Burt R. Rickards, '99, Carl J. Trauerman, '07.

The following men will represent their respective classes on the Alumni Council for the coming year: 1876, William P. Atwood; 1881, Arthur Winslow; 1886, Edward F. Miller; 1891, Gorham Dana; 1896, John A. Rockwell; 1901, Allan W. Rowe; 1906, Edward B. Rowe; 1911, Orville B. Denison; 1916, Howard P. Claussen; 1921, Reginald H. Smithwick; 1926, Eben B. Haskell.

Accepting the report of a special nominating committee, the following elections to Advisory Councils were made: *Advisory Council on Athletics:* Allan W. Rowe, '01, until 1933 to succeed himself; Atwood P. Dunham, '17, until 1933 to succeed Harold S. Wilkins, '14. *Advisory Council on Undergraduate Publications:* Harold E. Lobdell, '17, until 1934 to succeed himself; two additional members for two years to be selected later. *Advisory Council on Tech Show:* Frederick Bernard, '17, until 1933 to succeed himself; Hiram Y. Waterhouse, '15, until 1932 in addition. *Advisory Council on Boat House:* John L. Batchelder, '90, until 1933 to succeed himself; William B. Thomas, '29, in addition. *Advisory Council on Walker Memorial:* Arthur D. Little, '85, until 1933 to succeed Arthur L. Shaw, '09; Clair E. Turner, '17, until 1931 in addition; Lawrence Allen, '07, until 1932 in addition. *Advisory Council on Musical Clubs:* William P. Lowell, Jr., '26, until 1933 to succeed himself; Charles F. Park, '92, until 1933 in addition.

Reporting for a committee consisting of John A. Rockwell, '96, Henry E. Worcester, '97, and Allan W. Rowe, '01, to prepare resolutions on the death of Major Frank H. Briggs, '81, Dr. Rowe read the following:

"In 1898, as the result of a joint conference of representatives of the Alumni, the Faculty, and the student body, the Alumni Council on Athletics came into being. Major Frank Harrison Briggs, '81, was a prime mover in the preliminary deliberations and became the chairman of the Council at the time of its establishment. Dealing constructively with the problem of undergraduate athletics as a whole, he outlined policies and laid down principles for guidance that, except for such minor modification as has been made necessary by changing conditions, determine the whole course of this important student activity.

"With unfailing vision and prescience he anticipated and advocated such advances as the Freshman rule, intramural competition, and other commonplaces of present-day collegiate athletic practices, years if not decades before they found any general recognition and acceptance in the college world at large. Imbued with the high principles of true sportsmanship, by precept and by counsel he was unfailingly active in the promotion of better standards and his wide circle of affiliations made his influence significant and far reaching. His simple profession of faith may be found in the lines inscribed at his instance over the gate of which was presented by his Class of 1881 to the Institute many years ago.

'Not the quarry but the chase
Not the laurel but the race
Not the hazard, but the play
Make me, Lord, enjoy alway!'

With a just recognition of his great services not only to his Alma Mater but to the whole world of amateur athletics,

"*Be it resolved*, that the Alumni Council of the Massachusetts Institute of Technology, of which body he was for many years the agent and representative, express a sense of deep and abiding loss in the death of Frank Harrison Briggs of the Class of 1881, and further,

"*Be it resolved*, that the Alumni Council attest for all time its recognition and appreciation of the great service rendered by him to the cause of college athletics, among which his Alma Mater has ever been a chief beneficiary, and finally,

"*Be it resolved*, that these resolutions shall be spread upon the records of the Alumni Council and copies of the same be sent out to the members of his family."

As spokesman of the Executive Committee, Harold B. Richmond, '14, its chairman, announced that Professor Charles E. Locke, '96, had been their unanimous choice as Secretary for the ensuing year. Professor Locke has always been closely identified with Technology affairs and the activities of his Class, being its Secretary since the Class graduated. Few men are better known by Technology Alumni.

Merton L. Emerson, '04, Frank L. Locke, '86, and J. Rhyne Killian, Jr., '26, were elected by the Council to serve on the Nominating Committee until June 30, 1933.

Purdy

PROFESSOR CHARLES E. LOCKE, '96, WHO IS TO BE SECRETARY OF THE ALUMNI ASSOCIATION FOR 1930–1931

An inventory of the accomplishments of the evening shows that twenty-two reports of officers and committee chairmen were read and either accepted or placed on file. During the past year the membership of the Alumni Association has increased by 628, bringing the total for the year to 14,614.

Two Deaths

THE deaths on June 5 of William Emery Nickerson, '76, and on June 14 of George E. Merryweather, '96, deprives the Institute of two of its most distinguished Alumni and helpful friends. Mr. Nickerson, who was Vice-President and a director of the Gillette Safety Razor Company, was associated with the Classes of 1874 and 1875, although his degree was taken with the Class of 1876. From 1872 to 1876 he was an assistant in the Institute's laboratory of general chemistry and quantitative analysis and a private assistant to Professor William R. Nichols who later became Acting President.

Mr. Nickerson early displayed an inventive genius which was to culminate in his making the Gillette razor a practical success by inventing the automatic machinery and processes for producing it. He took out the first patent for electrical appliances for stopping elevators at predetermined floors, made the only commercially successful incandescent lamp without the hermetic seal, and invented automatic machinery for weighing materials in packages.

ANNA B. GALLUP, '01, CURATOR-IN-CHIEF OF THE BROOKLYN CHILDREN'S MUSEUM. RECENTLY SHE WAS AWARDED THE GOLD MEDAL OF THE NATIONAL INSTITUTE OF SOCIAL SCIENCES

In 1928 he was nominated by the Alumni Association and elected by the Corporation a term member of that body, and in the spring of that same year he suggested and endowed a new professorship at the Institute known as the Chair of Humanics. One of his last acts before his death was his contribution to the Technology Loan Fund as recorded on page 439. In addition to his Institute benefactions, he provided Boston University with an athletic field. He delivered two Aldred lectures at the Institute to be long remembered.

Mr. Merryweather, from 1927 to 1929 a Vice-President of the Alumni Association, was President of the Motch and Merryweather Machinery Company, Cleveland, Ohio. In addition he was director of the Central National Savings Bank and Trust Company, P. A. Geier Company, and the Davenport Machine Tool Company of Rochester, N. Y. At one time he was President of the Associated Machine Tool Dealers of the United States and Vice-President of the Association for Criminal Justice. During the War, he was a member of the War Industries Board.

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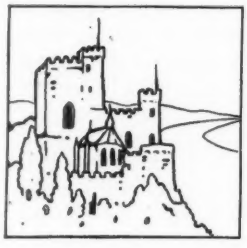

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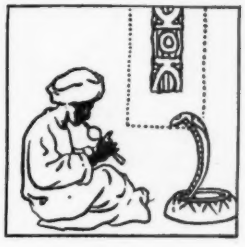

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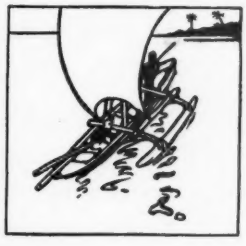

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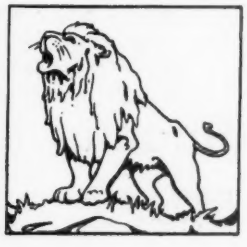

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TIME

(*Continued from page 429*)

its nature. To so call it may be convenient and helpful, may lead to important and surprising results, but to call it so simply forces upon us the necessity of so defining "dimensions" anew as to explain the nature of the four-fold group. Time, of course, is measured by motion, the fundamental time-motion unit being the complete rotation of the earth on its axis; that unit being divided into twenty-four parts to obtain a smaller and more convenient unit. Let us suppose that the solar system is fixed. It will be remembered that, at the siege of Jericho, Joshua commanded the sun to stand still. What is really meant is that the earth ceased revolving, but the divine inspirer of the Scriptures being, evidently, a scientist, was content to subscribe to the Ptolemaic working hypothesis until such time as Copernicus should have advanced a better one. The sun, then, stood still; so that from the beginning of the battle to the end no time elapsed; no motion, no measure, no time. To put the matter otherwise, as no "time" elapsed there was no time to do anything and, therefore, no battle was fought. The writer will leave it to his readers to remove by similar reasoning the other three dimensions and thus prove that there was no Jericho and no Joshua. And, finally, it would be interesting to have Sir Oliver Lodge "call up" Joshua and obtain from him an interview on the subject.

Refining our measurements does not remove the difficulty. Even with the velocity of light as a fundamental unit there is motion of light along a path; motion of something through something. That is to say, something happens, there are events. "We look around for any series of recurring events, such that the time-interval between the events will be the same." What do we mean by the "time-interval being the same?" And if we know, how shall we measure it? Moreover, is it the *percept* of the successive events that is "time" or our *concept* of the succession? And do the percept and the concept agree?

IT IS the opinion, or guess, of the present writer that the basis of the time-idea is physiological, and lies most probably in the act of breathing. In this *rhythmical* act the percept and concept are so closely connected as to seem identical, or synchronous. Less obvious physiological rhythms, the heart beat, for example, confirm the time-idea. Indeed, it seems highly probable that organic life, animal and vegetable, is a composite of rhythm. If matter is energy then the space-idea may have evolved through the eons from the concept of energy-permanence of the organism as a whole, while the time-idea arose from the concept of innumerable rhythmic energy beats taking place in the organism. Both of these concepts are strengthened by observation of the external world, in which man still strives, by more and more exact measurement to confirm their truth. Indeed, in the universe as a whole, as man perceives it and conceives it, the basic idea is *rhythm*, and that rhythm is Time. This idea seems to be deeper than Professor Gunn's "ever-changing present, sequence of before and after objectively given, out of which a relation of past, present, and future is constructed," for this past, present, and future is the first crude effort to measure the rhythm, (*Continued on page 458*)

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TIME

(*Continued from page 456*)

the intangible thing, Time. That this physiological rhythm is the basis of the time-concept seems to be verified by the fact of time-awareness of hypnotic subjects. This time-awareness, often remarkably exact, and implying measurement of some kind, must have its seat in the subconscious mind, that strange storehouse of things from libido to "genius" acquired by inheritance through numberless generations.

The difficulties of exact time measurement are enormous; no less difficult is the exact expression of the meaning of metaphysical time. To the average scientist the latter difficulty would seem greater than the former because of the prevalent and perverse notion that to measure a thing is to know it.

Neither to Professor Gunn nor to the present writer would such a point of view be acceptable, though they would be in full agreement as to the difficulties involved in the final synthesis of the time idea. These difficulties the author considers, and tries to overcome, in his concluding chapter. His success is not complete: how could it be when involved in the idea of time are all the fundamental ideas of metaphysics: the nature of Reality, the meaning of Space and Motion? It seems sufficiently clear that Time is not something outside of the universe, but something within it, a part of it. Space and time and motion, or events, whatever all these may be, are parts of the universe. Whether there are other parts, of equal or greater importance, need not be here discussed. But Time cannot be explained in terms of Space. A four-dimensional world of space-time is mathematically determined. The value of the concept must not be underrated. But such a world is difficult, at least, if not impossible of apprehension qualitatively. "A curve in a space of (four) dimensions is really a curve in (three) dimensions *being actually traced*." But when that is stated is the meaning of Time more clear? A four-dimensional space-time world is a world of physics and mathematics, perfectly justifiable and most useful in those realms, but the question may be asked, is that the world we know? Man cannot live by science alone any more than he can live by bread alone. Space and Time may not be isolated, may never exist apart from each other, and yet may not be identical; and Space-Time as an entity, a "continuum of events," as Whitehead calls it, is simply a mathematical scheme for the organization of events. We join the unlike Space and Time into Space-Time, in order more conveniently to present the scheme of events, just as "Movie" and "Talkie" are combined the better to present a so-called motion picture drama. Nor do elements of similarity in Space and Time connote identity. There is a perspective of conceptual time analogous to that of space, so that in remembrance of past events these, though at equal intervals, seem the closer together the more remote they are in the past, just as in a long line of telegraph poles those farther away seem the closer together. Turn now to the poles running in the opposite direction. The space-perspective is the same forward as backward. But turn to the future of time and the perspective is changed. The more remote the future events the farther apart they seem.

(*Continued on page 460*)

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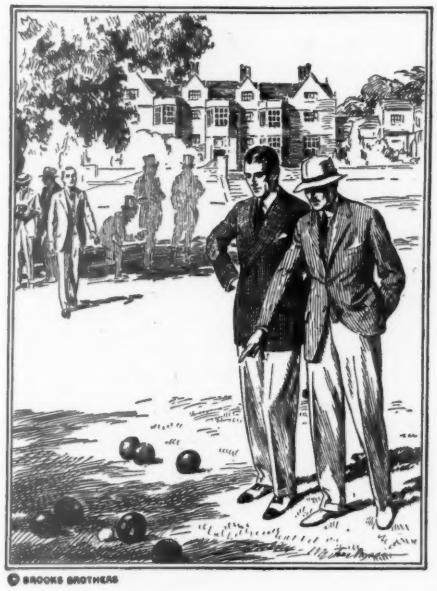

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TIME

(*Continued from page 458*)

If Space-Time be more than the sum of space and time, if it be "the one and only matrix of generation," it evidently contains an element of mysticism of which one may say, as of the rolling of Prince Agib's gentle spirit, it "is pretty, but I don't know what it means." But perhaps it means "emergent evolution," though doubtless the emergent evolutionist would object to being called a mystic.

The metaphysician, says Professor Gunn, need not "give his allegiance wholeheartedly to (any) one of these (three) theories of time:" the Absolute Theory of Newton, the Relational Theory of Leibnitz, the Relativity Theory of Einstein; for he must consider also psychological time, in which the present (which in mathematical time is a point "the last instant of a series going back into the past and first of a series extending into the future) is a duration of seven to eight-tenths of a second; a definite, if irregular, slice or moment — the "specious present" — as if time, too, were measurable in quanta. Perhaps quanta themselves are the pulsations or beats of the primordial cosmic rhythm.

Thus "our perceptual experience of time contains both the element of successiveness *and* of duration." But perception alone does not define "*real*" time for the metaphysician who "is concerned with the whole," and must steer a course between the Scylla of mathematics and the Charybdis of psychology. For him (*Concluded on page 462*)

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TIME

(*Concluded from page 460*)

"Time is . . . a continuum of events coming into being in a continuously changing present. . . . The realm of mind and of external nature are both temporal in character." The Absolute and the Relational Theories maintain that "a certain fixed time-lapse separates" any two given events; the Theory of Relativity, that no single, absolute interval of time separates them. Having rejected the two former on philosophical grounds, the metaphysician is indifferent to the last because it is concerned with the measurement, not the nature of Time. But it must be noted that "Time" is used in two senses; the one given above, the more general, is Time as a concept. There is also Time as a percept in which use it applies only to the continuously changing present. It is the latter which, for the most part, mankind knows and uses. This Time consists of a short interval, or duration, varying with the individual, and containing events about to vanish and events about to appear as well as events that are present.

The writer would like to make Professor Gunn's book "collateral reading" for everyone engaged in or interested in education. He would make it "compulsory reading" for every teaching scientist. The result would be — no, the result would be that things would remain as they are. For the average man times would not change; Time for him would still mean an alarm clock, a "time-clock", or a fancy wrist watch. To encourage possible readers, however, the writer cannot refrain from quoting from the Problem of Time the following gem:

> "There was a young lady named Bright
> Whose speed was faster than light;
> She eloped on a day
> In a relative way,
> And returned on the previous night."

One suspects that the fast young lady in question was, if not the Red Queen herself, a near *Relative;* perhaps her flapper granddaughter.

PRINTS—THEIR USES AND ABUSES

(*Continued from page 433*)

Yet, for all the comic aspect that some of them wear, these prints present the only adequate panorama of their time and a very interesting time it was. The lithographs which were concerned purely with places and events provide information that may be had in no other form. Those which are not of value as news do have certain decorative qualities which help to preserve the air of the period from which they come, and for that reason alone may be desirable in homes that strive to reconstruct the semblance of an earlier time. In the years of exploration and colonization, that were necessary to the formation of this country, there was a fertile field for the man who could wield pencil and brush. We have a pitifully inadequate contemporary record of pre-Revolutionary days, and much of our early history (*Concluded on page 464*)

"NEW DORMS"

In the foreground New Dormitory Units Nos. five, six, and seven are shown in process of construction. This new group will form the West Wing of the Dormitory Quadrangle and will be connected to Units Nos. one, two, and three, its existing companion building, by an underground passage.

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PRINTS—THEIR USES AND ABUSES

(*Concluded from page 462*)

that is clouded or obscured by contradictory accounts might be cleared had there only been pictorial recorders of events as they occurred.

Yet we are thankful for what we have and collectors of these story-telling prints will agree that there can be no greater thrill than the acquisition of an unknown or rare piece that sheds some light upon a point in controversy. Some of us collect naval, marine, and military prints — some turn to those which bear upon scientific or industrial development. Others find their *metier* in political and territorial material, or search with unwearied anticipation for portraits of the famous of all times and stations. One thing is sure, "as sure as death and taxes": for every print that deals with human activity in any form there is somewhere a collector. Both millionaire and manual laborer are subject to the inherent craving for pictures of one kind or another and once an addict — always an addict. There is no escape.

DYNAMIC LOADS

(*Concluded from page 435*)

this condition will be true. But when such an increase in physical strength is accompanied by radical changes in the structure of the materials, so that the fatigue limits do not increase proportionally, then these fatigue limits determine the extent to which the load can be increased. A notable example of this is the behavior of certain bronzes used for bearings and worm gears. The best bronze here is the one which has the highest physical strength without any loss of malleability, or the ability to be cold-worked without surface failure. A relatively soft bronze will be cold-worked in service, hardening and increasing the actual physical strength of the surface of the material, whereas a harder and stronger bronze will not cold-work, and its surface will start to disintegrate under load without any appreciable increase in hardness. Furthermore, because of its structure, the size of the released particles of material will be larger than those released from the softer material and will thus cause more destructive cutting than those from the softer bronze.

To sum up: The maximum dynamic loads on rubbing surfaces of mechanisms are impact loads, their intensity being the sum of the transmitted load plus an increment load which is practically a constant for any given speed condition on any given mechanism. The stresses set up by these impacts must not exceed the fatigue limits of the materials if excessive wear is to be avoided. A margin of safety would appear to be a more logical value to use in such cases than a factor of safety. Dynamic loads are not directly proportional to the transmitted loads, hence the use of velocity factors is incorrect and misleading.

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DR. COMPTON'S ADDRESS

(*Continued from page 438*)

Every application of science presupposes a discovery of science to be applied, so that the useful applications of science are in the last analysis limited by the extent to which scientific research has been successful in uncovering the hidden forces of Nature. Then, when these scientific discoveries are put to the service of man, there is always a limit to the available extent of this service, a limit set by some such thing as a defect of material, inability to solve an equation, or some disturbing factor. So here again it is the province of research to push back or remove these limitations. While, therefore, in its humble beginnings, the greatest service of an Institute of Technology might very well have been to acquaint men with the laws of science and the technique of their application, an Institute of Technology today, to perform its greatest service, must take the lead in actually developing science and its applications as well as in technological instruction. . . .

I hope, therefore, that increasing attention in the Institute may be given to the fundamental sciences; that they may achieve as never before the spirit and results of research; that all courses of instruction may be examined carefully to see where training in details has been unduly emphasized at the expense of the more powerful training in all-embracing fundamental principles. Without any change of purpose or any radical change in operation, I feel that significant progress can thus be made.

Second let me emphasize the supreme necessity of maintaining a faculty of absolutely first grade men, despite the increasing difficulty of doing so. Here, as in every organization, the question of personnel is the supreme issue. But, unlike other organizations, an educational institution can make a perfectly logical and unanswerable argument that its need of the best men should supersede the claims of any other organization. For it is these men in the educational institutions who train and inspire all the others; their abilities are renewed and made available to the world in every graduating class. The folly of sending our youth to second rate teachers in the hope of obtaining a first-class training is too absurd to discuss. And yet this is a very real danger, for industry is competing with universities for the best men, often taking them and then perhaps later finding fault with the institution for not giving its students a first-class training! I could go on at great length on this topic, which is one so easy to argue, yet so difficult practically to solve.

Several things, I believe, conspire to make this situation so serious. Industry can outbid an educational institution for a man if it wishes to do so. An industry may be short-sighted, looking only to its profits for the next few years. Or it may realize the situation and, if left to itself, would not try to take a certain man from an educational institution, — but realizing that if it does not some competing concern will, it proceeds to invite the man to join its staff. There are instances in this Institute in which an industry has taken man after man from key positions, leaving a department seriously embarrassed, crippled and criticized. . . .

How, then, is this complicated situation to be handled? I doubt whether any rules, agreements or other artifices can hope to solve it. The solution (*Concluded on page 466*)

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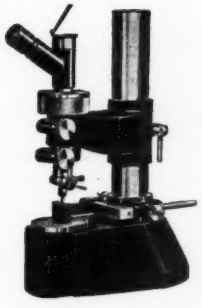

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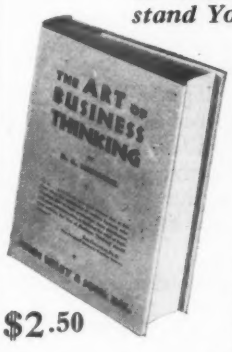

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DR. COMPTON'S ADDRESS

(*Concluded from page 465*)

must be found, I think, according to the regular economic laws, that is, by the Institute's being in a position to offer to the man it needs, a sufficient emolument in salary and advantages to hold him or, failing that, to secure another first-class man in his place. And the industries must, for their own ultimate self interest, see to it that the Institute is financially able to retain on its staff the leaders in the various scientific and technical professions. . . .

The third problem of the future, to which I should like to call attention, is one which is not so fundamental as the two just discussed, but which is nevertheless very important and interesting. It is the problem of finding the most advantageous way in which the Institute can coöperate with technical industries in the solving of their problems. As you know, a great step in this direction was taken with the inauguration of the so-called 'Tech-Plan' and the formation of the Division of Industrial Coöperation and Research. Very valuable work has been done under this plan, but it has also had certain unsatisfactory features. I know from personal experience that contact of a university teacher with the practical problems of an industry can be professionally extremely stimulating and valuable. And certainly the Institute should render every assistance in its power to any worthy cause within the range of its interests. The problem really consists in improving, if possible, the way in which this aid is rendered. . . .

These problems which I have mentioned, and to which others might be added, are simply sign posts pointing out the directions which our efforts must take in order to do our work most effectively. It is a work whose results will ultimately affect every man, woman and child and which should command the support of all except those few who are timid in the face of power or who for some reason fear to let Man understand too much of Nature. The Massachusetts Institute of Technology looks to us, who love and respect Nature, to work out her future development. I join you in this work because I believe in its value, and for the same reason I feel confident of the coöperation of each of you, according to his position and opportunity. In its direct and indirect influence I can conceive of no more valuable service."

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BOOKS

(*Continued from page 444*)

of biographies. Here are some: Rupert Hughes' third volume about the first President and Father of his Country; A GENTLEMAN REBEL (Farrar and Rinehart, Inc.) in which John Hyde Preston retells the exploits of Anthony Wayne as did Thomas Boyd in MAD ANTHONY WAYNE published last autumn by Scribner's; Charles Coleman Sellers' BENEDICT ARNOLD, THE PROUD WARRIOR (Minton Balch and Company); JOHNSON OF THE MOHAWKS by Arthur Pound and Richard E. Day (The Macmillan Company). The subject of the last-named incidentally was not an Indian but Sir William Johnson, Bart., an Irish gentleman, superintendent for George III of the Six Nations and of all other Indians north of the Carolinas.

GEORGE WASHINGTON: THE SAVIOUR OF THE STATES, 1777–1781 (William Morrow and Company) treats the period of Washington's life as military leader of the Colonies. Mr. Hughes, dubbed an iconoclast upon the appearance of the first volume of the series, has in this book put Washington on a higher pedestal than heretofore. His writing is heavily documented and Mr. Hughes' painstaking efforts to prove nothing but the truth are quite apparent.

Arnold fares well at the hands of Mr. Sellers, much better than he did in those of Jared Sparks whose "Life and Treason of Benedict Arnold" appeared in 1835. To Mr. Sellers, Arnold appears a man sorely tried, a hard-headed self-seeker who knew how to fight and never shirked, who literally shed blood for the cause, a brave officer who led a detachment to the very gates of Quebec and who probably saved the day at Saratoga, only to be passed over by the Congress which long denied him promotion and afterward hounded him about his accounts. Washington stood by him in his troubles, though Arnold's nature made him quarrel with every immediate superior he ever had, and it was Washington who appointed him to the West Point command. From this vantage point he plotted treason, was discovered, escaped, fought against his former comrades for a time, and ended his career as a British brigadier.

JOHNSON OF THE MOHAWKS tells of a great man of Colonial North America whose memory needs and deserves such a worthy document. William Johnson came to America from Ireland at the age of twenty-three as steward of the properties of his uncle, Admiral Peter Warren. He died a baronet (one of the two residents in America to bear that title), a major general, and in all probability the richest man in the Colonies. The influence he wielded over the Six Nations had a profound bearing on the course of events for it was Sir William who brought about the first serious split in the Iroquois Confederacy.

He directed the successful expedition of 1755 against Crown Point and in September of the same year defeated the Indians and French at the Battle of Lake George. For the first of these he was created a baronet and received

(*Concluded on page 468*)

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BOOKS

(*Concluded from page 466*)

the thanks of Parliament; for the second his King gave him 100,000 acres north of the Mohawk River. Later, in 1760, he was with Amherst at the capture of Montreal.

On his land, at Johnstown, N. Y., he built Johnson Hall, a courthouse, and a jail. All three still remain — the last two being still used for the purposes they were in Sir William's day. The estates, however, were confiscated as his heir, Sir John, chose to remain loyal to the King, organized a regiment of Tories known as "Johnson's Greens," and became quite unpopular.

Some thirty years ago there appeared a series of historical novels which treated of that part of the Revolution which particularly affected the great landed families of northern New York: the Johnsons, represented by Sir William, Sir John, Guy Johnson, and Colonel Claus; the notorious Butlers, father and son; the Schuylers, Van Rensselaers, and others. Among the titles were: "Cardigan," "The Maid-at-Arms," and "The Reckoning." The author of these "best-sellers" of their day was Robert W. Chambers, a resident of the section, who is generally credited with having taken no great liberties with history.

JOHNSON OF THE MOHAWKS surely will never attain to the popular appeal accorded Mr. Chambers's writings but Dr. Day, editor of historical manuscripts of the State of New York, has unearthed material which makes the Johnson legend more in focus than heretofore. Tradition still has it that Sir William, faced with the breakdown of his life work through the impending Revolution, committed suicide. This Dr. Day brands untrue. Another fable has it that Sir William would have espoused the cause of the Colonies. Unfortunately, a study of the evidence (unpalatable though it may be to the D. A. R.'s) makes it only too likely that Sir William, if he had lived, would have commanded "His Majesty's American Forces," in which case the War of Independence might have been only an unsuccessful rebellion. H. E. L.

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